NEW SCIENTIST

5 January 1961

Towards giant space vehicles

PROFESSOR A. D. BAXTER, *de Havilland Engine Co. Ltd.*

Britain's backwardness in higher education

Dr B. V. BOWDEN, *Principal, Manchester College of Technology*

The unknown Indian Ocean

Dr G. F. HUMPHREY, *President, ICSU Special Committee on Oceanic Research*

What can we do with whiskers?

Dr GEORGE A. HOFFMAN, *the RAND Corporation, California*

The search for a chemical "scarecrow"

Dr C. J. DUNCAN, *University of Liverpool*

Puzzles and paradoxes

NEW WEEKLY SECTION by T. H. O'BEIRNE

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STEEL-A RECORD YEAR

Biggest-ever output flows from Britain's busy furnaces

BRITAIN'S steel production in 1960 was the greatest ever recorded: over 24 million ingot tons. Output was running close to capacity in almost every section of the industry. Total production was *twenty per cent* above 1959.

Britain's capacity to produce steel has been increasing by leaps and bounds as a result of the £900 million which has been spent on three great development programmes. Last year alone the steel industry spent £130 million on development, *one-sixth* of all the money spent by manufacturing industry on capital investment in this country.

In the next four years the industry has already planned to spend another £450 million, and to raise its production potential by nearly one-third.

Another article on the opposite page describes a great new development in Scotland, which brings with it the promise of greater prosperity across the Border. Also in hand is a vast project near Newport, Monmouthshire. This is the Spencer Works of Richard Thomas & Baldwins, which when completed will be Europe's most modern integrated steelworks. An enormous green-field site has been laid out, and work is going ahead at a tremendous pace.

Expansion under way

Three more new mills to roll improved and more efficient sections for building and constructional work will come into operation shortly at Colvilles, South Durham, and the United Steel Companies.

Among the very large schemes announced in 1960 were the Tinsley Park scheme of the English Steel Corporation to increase their output of alloy and special steels, costing £26 million; the United Steel Companies' plans at Appleby-Frodingham and Samuel Fox, costing £32½ million; a Dorman Long plan costing £36 million; and the entirely new works at Rotherham of the Park Gate Iron and Steel Company which will cost £55-60 million.

Output up all round

All sides of the steel industry have shared in the increase in output which took place in 1960. Heavy sections and bars were 26% above the previous year, light sections and bars were close behind with a 24% increase, with plate running them close with a 23% increase. Alloy steel was 22% up, sheet and tinplate 14% up, and tubes 12% up.

What are the prospects for 1961? The industry will be able to improve on the 1960 record figure. Capacity in 1960 was nearly 26 million tons – this year it will be 27 million tons. All the time, the industry is expanding to meet future demand. This expansion is geared, not to any yearly fluctuations in our manufacturing activity, but to the steadily rising curve. It is in the confidence that this curve *will* go on steadily rising, that the many far-reaching development plans in steel are being pressed forward without slackening.

Exports a record too

Besides the enormous amount of steel which Britain exported last year in the form of manufactured goods, the steel industry's own direct exports of steel were booming.

Over 4 million ingot tons, valued at some £230 million, went into direct exports of steel in 1960 – a post-war record.

Latest available figures show that well over one-third of this went to Commonwealth countries: exports to the Commonwealth were 20% up on 1959 in tonnage. Tonnage of exports to Western Europe showed a similar upsurge. Exports to the Soviet Bloc including China, though small by comparison with total exports, also showed an increase.

Two new steels for supersonic flight

What will the supersonic airliner of the future be made from? Opinions are divided, but the Bristol T.188 research plane, which has been built to explore the problem of flight at speeds of the order of 1,800 m.p.h., is made from heat-resistant stainless steel to withstand the high temperatures caused by the friction of the air at such speeds.

The steel scientists of Sheffield have produced two new types of steel from the experience of the Bristol T.188. Although heat-resisting alloy steels had already been in use in jet engines for many years, these were not suitable for making large thin sheets of the kind required to build an airframe. The new steels produced in Sheffield are capable of being made in large sheets, and can be "worked" into the complicated shapes required.

New bridges hang on steel

The new road bridge over the Firth of Forth is being anchored into the solid rock with specially thick steel cables. They are 1½ in. in diameter and have a breaking load of more than 350 tons. Over a thousand of these cables, enclosed in groups of four in 4½ in. diameter steel tubes, are embedded 240 feet into the rock. Other similar cables are being used to support the 110 ft. high towers until the main steel suspension cables are in position.

Other new bridges using steel suspension cables are planned over the Wye and Severn. Altogether some 70,000 tons of steel will go into the three bridges.

STEEL—THE YEARS AHEAD

New strip mill promises brighter future for thousands *BY MARGARET STEWART*

THERE is no problem of mass unemployment in Britain today as there was before the war. But there are still black spots. Scotland has 72,000 jobless, 3·3% of all its workers. In Greenock and Port Glasgow the proportion is as high as 8·1%. The national average is 1·6%.

New light industry has brought 50,000 jobs to the Clyde valley since the war. But Scotland is still over-dependent on heavy industry.

The steel industry is playing a vital part in redressing the balance, and bringing hope of an industrial renaissance. Colvilles, one of the leading British producers, are going ahead with ambitious plans to raise their steel-making capacity from 2·3 to 3·3 million tons a year. Their most important and imaginative project will produce 500,000 tons of steel sheet and 175,000 tons of light plates a year. It is in two parts – a hot strip mill at Ravenscraig and a cold reduction mill at Gartcosh, 8 miles away.

This is a completely new development for Scottish industry, traditionally a user of heavy steel. The Scots hope that plentiful supplies of sheet steel will attract manufacturers of cars, car accessories, refrigerators, washing machines, cookers, and office furniture. A canning industry could follow. Rootes and the British Motor Corporation have already decided to go north.

Snowball effect

Sir Andrew McCance, chairman of Colvilles, told me: "But for the strip mill, these motor car firms would not have elected to come to Scotland. They will bring a lot of ancillary trades, and the cumulative effect is bound to be substantial."

Mr. John Lang, steel union leader, chairman of the Scottish Board for Industry, and treasurer of the Scottish TUC, said there had been many encouraging enquiries.

The Government's decision to lend Colvilles £50 million for Ravenscraig caused controversy in Parliament. Labour spokesmen said it was wrong to use public money for the benefit of shareholders. Conservative back-bench MPs attacked the loan as "bastard socialism".

But the Scot-in-the-Street was spoken for by Mr. Lang: "We don't care a damn where the money comes from, so long as our men don't have to walk the streets looking for jobs."

Plans are going ahead in spite of the recession in the car industry. What extra employment will result? Perhaps another 1,500–2,000 steel workers will be needed. The car developments should provide upwards of 10,000 jobs directly. The Pressed Steel Company is expanding its plant near Paisley to produce bodies for cars and commercial vehicles. A new development by the accessory firm of Rubery Owen, scheduled for Bathgate, will mean work initially for about 200. And there will be a "snowball" effect from these developments within the next few years.

MARTIN: "A dandy layout"

100% success

In spite of belting rain, looming fog and the grime of the Glasgow "countryside", it was stimulating to visit the Ravenscraig and Gartcosh sites. The men on the job impart their own infectious enthusiasm.

William Banks, general manager of Ravenscraig, has watched its progress for three years. "I have a great deal of faith in the future of the steel industry, and of our company in particular," he said. "I believe we shall have 100 per cent success."

More steel-making capacity is being installed to supply the new mill. Ravenscraig will be one of the first large plants in this country to adopt the "L.D.-A.C." process, one of the most modern and economic methods of making steel, using oxygen and lime.

About two-thirds of the output of the hot strip mill will be sent to Gartcosh to be cold-rolled into high quality sheet.

There is a strong reason for building at Gartcosh. Nine hundred men work there in the old hand mills of Smith and McLean. Their livelihood depends on steel.

Progress at Gartcosh, as at Ravenscraig, is well up to schedule. George Martin, the "boss", told me that American experts to whom he showed the plans had commented, "That's a dandy layout."

At first 500 men will be employed, rising to 1,000. Most of Smith and McLean's men will be found work. "We will go out of our way to place them in suitable jobs," I was told. The older men will be taken care of by a pensions scheme.

There is naturally great interest in the new plant. Everyone I met hopes to be taken on.

William Dickson, 21, who works as a "breaker-down", splitting steel bars, expects to be transferred and hopes for higher earnings. Leading furnaceman William McCormack, though about 60, also hopes to be taken over. He vividly recalls the bad days of mass unemployment and short time in the 1930s.

The two men who will manage the hot and cold strip mills are both in their early thirties. James Watson, manager-designate of the hot strip mill at Ravenscraig, is 34. His opposite number at Gartcosh, James Easton, is 31. Both have been through Colvilles' 'sandwich' courses at the Glasgow Royal College of Science and Technology. Both are brimful of confidence in themselves, their industry and the future of Scotland.

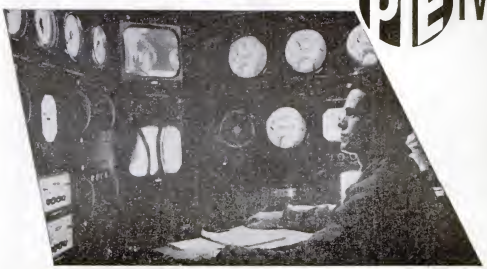
WATSON: "Finest thing that ever happened"

Says Watson: "This is the finest thing that has ever happened to me." Says Easton: "The prospects couldn't be better."

Issued by the British Iron and Steel Federation

In the new underground plant at Fort Dunlop the testing of tyres at very high speeds is being facilitated by the use of television. Enormous centrifugal forces are developed on test tyres at speeds in the region of five hundred miles an hour and, for reasons of safety, all operations are directed from an above ground control room. The industrial television system consists of two Pye cameras mounted on separate pedestals travelling along an optical bench. These are situated underground in a cubicle just outside the machine chamber.

PYE TV in Research



The precision control of camera movement and lens change is achieved in the control room, where two 14 inch monitors, centrally placed between two banks of recording instruments, present the selected camera views; in addition, a calibration grid, electronically superimposed on the television image, enables tyre movements to be measured accurately during the tests. This system gives the operators the closest possible observation under conditions of perfect safety.

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Notes and Comments

Who next?

THE New Year opens to the reverberations of the testing of the third French atomic bomb in the Sahara. The year 1960 ended with speculations about whether the Israelis might make military plutonium in the 24 MW reactor they are building with French aid in the Negev; and with a warning in New York by Sir Charles Snow that if enough nuclear weapons are made by enough different countries, some of them are going to blow up. As long as the development and construction of weapons proceeds without restriction the "nth country problem" will continue to harass an already nervous world.

Following the example of the USA, the Soviet Union and Britain, France appears to be aiming to equip herself with serviceable nuclear weapons and the supersonic aircraft to deliver them in about three years' time. It is difficult to believe that China, which is known to have research reactors and may well have large reactors also, can be far behind. Apart from these two countries, any that has $100 million to spare, has the appropriate modern industries and has embarked on a programme of nuclear research and engineering, could produce its first bomb without much difficulty within five years.

For the sake of its peaceful application, the "know-how" of nuclear engineering is being widely spread throughout the nations of the world. As a matter of policy, the USA and Britain have insisted on assurances that reactors supplied to other countries will not be used for military purposes. However, the basic methods of nuclear weapons are now common knowledge, and if the will to make them exists the means will be found; experience gained in peaceful research will be readily adaptable to military ends.

It may in future be easier to make nuclear weapons. If the designs developed by the experienced bomb-makers for "tactical" weapons of relatively low explosive power could by great ingenuity be matched by other countries without experience of standard bombs, their requirements of fissile materials for their first bombs might be less. If experiments in controlled nuclear fusion reached the point at which they can provide a copious supply of cheap neutrons, it might be easier to convert natural uranium to plutonium explosive without the use of a large fission reactor. And if someone were to find a way of detonating a fusion (H) bomb without a fission (A) bomb core, the last brake on Mankind's ability to make explosions would be gone.

Even without such developments the situation is bleak enough. The well-known techniques for making U-235 in isotope separation plants or plutonium in reactors can carry many nations along the road to nuclear armament. If a rush were to begin—in a chain reaction of rivalry, pride and fear—the edifice of international cooperation in the peaceful uses of nuclear energy, so laboriously erected during the last few years, would be swept aside. If the number of countries possessing nuclear weapons increases from four to, say, eight, the number of pairs of such countries which could come into conflict increases far more rapidly—from six to 28. The problems of negotiating and policing a world-wide disarmament agreement might quickly reach the point of hopelessness. Perhaps, as the risks of delay become more starkly apparent, 1961 will see far more progress towards disarmament than the years which have lately passed.

European astronomers look to southern skies

THE European astronomers, the descendants of Galileo and Herschel, have no really big telescope to call their own. Their largest is the 74-inch reflector at St. Michel de Provence: the largest planned, the 98-inch for Herstmonceux. But with the 200-, 120- and 100-inch instruments in the United States and the 236-inch giant that the Soviet Union is proposing to build, it may be doubted whether there is any justification for further very big instruments in the northern hemisphere until the needs of the southern skies have been better met. Last month a group of West European astronomers who have long been anxious about this situation met in Paris to discuss their project; there were representatives from France, Belgium, Holland, West Germany and Sweden, with the United Kingdom present as an observer.

The idea is to build a 120-inch reflector telescope as a collaborative venture somewhere in the southern hemisphere. Astronomers from all member countries of the union would have the use of it for their work. The costs, which are bound to be considerable, would be shared between the sponsoring countries. In one stroke European scientists would gain an outlet to a large telescope which they at present lack and have at their disposal the largest telescope available for observing the rich southern skies.

Australia and South Africa seem to offer the most promising sites for the location of the projected telescope. If it could be located at an already existing observatory such as that at Mount Stromlo outside Canberra or the Radcliffe Observatory, Pretoria, much of the ancillary cost of approach roads (to bring the instrument to the site) and of living quarters and other buildings would be reduced. Various situations have been under consideration by the promoters of

Notes and Comments *continued*

the European scheme, but no final decision has been taken. Present thinking seems to favour a site in South Africa.

The five European countries involved in the scheme are definitely planning to go ahead, though it is not yet clear how much their respective governments are prepared to contribute. And where does Britain stand in the matter? When the plan was first mooted four years ago, Britain wished no part in it. At the recent meeting, her participation as an observer suggested a softening in the Government's attitude. The two largest telescopes south of the Equator are in Commonwealth countries, but this does not solve the problem of gaining an outlet for British astronomers to a really large telescope. No doubt the comment of the recent annual report of the Advisory Council on Scientific Policy, on the handicap of not having a large telescope available, will have its influence.

When the wheel rolled into Europe

WAR has obviously done a great deal for the arts of peace. If an Italian archaeologist reasons aright, at least one of the first pairs of horse-drawn wheels to roll into south-eastern Europe carried fighting men on the chariot platform. The oriental design of the wheeled vehicle has long been recognized. According to the late V. Gordon Childe and others, it seems to have turned up first in the Uruk period at Sumer in Mesopotamia during the first half of the fourth millennium BC. In the current *Proceedings* of the Prehistoric Society, Emmanuel Anati carries the story of the progress of wheeled transport several stages further by tracing its earliest known forms from Anatolia, where the Sumerians left it, *via* the Hittites, and then on to central Spain, northern France and Scandinavia.

To a great extent he has had to depend on ancient drawings and engravings of what appear to be war vehicles on tombs, rocks, caves and graves, and these were left behind almost exclusively on behalf of the nobility. Presumably nobody else could afford what were the Cadillacs of their day, and if labourers' wheel-barrows or muck-carts pre-dated them they have gone unrecorded so far.

Anati says the chariot was introduced into Palestine and Egypt with the Hyksos or Shepherd-kings invasion in the ninth or tenth century BC and into Anatolia, most probably as the result of Hittite invasions, shortly afterwards. The most northern points of Europe where Bronze Age chariots have been

recorded are in Sweden, especially Kiwik, Scania and Frannarp. From drawings at Frannarp it is clear that wheels were symbolic of Sun worship, but whether solid or spoked wheels came first it is impossible to say: solid wheels are still used on peasant carts in several parts of Europe.

One- or two-horse chariots with wheels of between two and seven spokes spread most rapidly in the northern Mediterranean region about the fifteenth or fourteenth century BC and they travelled north up the famous Amber Road, the trade route from Italy to Schleswig-Holstein, and along the Western Road via the Po Valley and the Col di Tenda pass.

Sun storm impeded balloon satellite's journey

STUDYING effects of solar disturbances on our atmosphere forms an increasingly lively part of current science. On 12 November last, America's communications satellite *Echo 1*, a 100 ft balloon which still circuits the Earth in just under two hours, increased its orbital period by two seconds as a result of the violent storm which "blew up" on the Sun. Two theoreticians at Goddard Space Flight Centre calculate that this is equivalent to doubling the very light atmospheric drag which acts on the satellite. R. Jastrow and R. Bryant think that the change, which lasted for several days, is most likely to be due to an increase in the mean density of the atmosphere in the satellite's path.

The altitude of *Echo 1* varies from 619 miles to 1,334 miles. At these heights the air is very thin and a large variation in its density can result from a slight expansion of the underlying layers of the atmosphere. One process which could produce such an expansion is the heating of the atmosphere by radiation or by charged particles, both of which are emitted by solar flares.

Only once previously has it been observed that the Sun's activity affected a satellite. That was in 1959, and the satellite was *Sputnik III*. It seems to be highly significant that both *Sputnik III* and *Echo 1* pass through the outer Van Allen belt of charged particles which surrounds the Earth. Thus *Vanguard 1*, confined to a latitude which does not permit it to intersect this belt, appeared to be unaffected by the recent solar storm.

During periods of greater activity of the Sun, flare emission causes the Van Allen belts to fill and empty with charged particles, but the exact mechanism of the process is still obscure. The recent observations on *Echo 1* may help to elucidate the physics of the sudden heating of the atmosphere.

Investigating the chemistry of mental disease

IT is now established that certain mental defects in infancy and childhood are due to biochemical lesions in the nervous system. May some mental disorders in adults, such as schizophrenia and depression, be similarly caused? Dr. Samuel Bogoch and his co-workers of the Neurochemical Research Laboratories, Harvard Medical School, Boston, USA, have been able to detect certain biochemical changes in the nervous system of patients suffering from these diseases.

They have been studying the carbohydrate-containing macromolecules of the central nervous system. One of these is brain ganglioside, which contains the water-soluble constituents neuraminic acid, hexosamine and hexoses on one surface of the molecule and the lipoid constituents, such as sphingosine and stearic acid, on the other surface. This arrangement suggested that brain ganglioside might be a membrane substance involved in receptor and transport functions in nerve cells. Immunological and pharmacological studies by the Harvard workers have in fact shown that this substance can act as a receptor for various viruses and markedly stimulates transmission within the nervous system. By the use of fluorescent antibody techniques they have demonstrated that brain ganglioside is located in the nerve cell.

The evidence is highly suggestive that, with related substances, brain ganglioside may be involved in controlling the entry and egress of a number of important constituents in the nervous system. One readily accessible part of this is the cerebro-spinal fluid (CSF), which circulates in the brain and spinal cord. Dr. Bogoch and his group have shown that in schizophrenia the CSF values of neuraminic acid are low, and that in

many patients the level correlates with their condition.

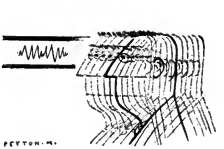
By careful fractionation they have estimated two other substances, hexosamine and hexose, which are combined with neuraminic acid in the macromolecular glycoproteins of the CSF. In patients with manic psychoses very high values for macromolecular hexose were observed—500 per cent above normal in some. In chronic brain diseases and manic psychoses the macromolecular hexosamine was elevated. In untreated schizophrenics, however, the macromolecular neuraminic acid was low. It was observed that in schizophrenics under treatment, either by drugs or electro-convulsive therapy, glycoproteins were synthesized with a normal or even supranormal level of hexosamine in the CSF, although subnormal amounts of neuraminic acid were present.

It would appear that there is a disturbance in the synthesis of macromolecular hexosamine and neuraminic acid in schizophrnia. The level of hexosamine is influenced by treatment, but that of neuraminic acid is largely unaffected. Since hexosamine is a synthetic precursor of neuraminic acid, this accumulation of a precursor without that of its derivative suggests the possibility of an enzyme block in the nervous system in schizophrenia.

Atomic, earthquake and oil scientists meet

THERE has been a certain coolness of politicians towards scientists since the experts changed their agreed opinions about the feasibility of detecting clandestine atomic bombs. However, a meeting recently at Cambridge showed that, in Britain at least, active steps are being taken to resolve the differences that have arisen between American and Russian scientists. The Atomic Weapons Research Establishment arranged that its people engaged on seismic investigations should get together with the Cambridge University Geophysics Department and with earthquake seismologists and oil geophysicists.

The earthquake experts and the oil prospectors told the atomic energy scientists how they operated; and, in turn, they were given an up-to-date account of the listening problem, which has been accentuated by the idea that bombs could be muffled by exploding them in large underground air-filled cavities. However, while the present state of the seismic art is not adequate to detect all explosions that occur underground, it is certainly possible to pick up any large ones, and there are several promising



lines along which improvement might take place. It would, of course, accelerate the improvement if the proposed world network of test-control stations were to be set up straight away in order to gain more experience of the earthquakes.

It was interesting to hear some of the diehards defending the traditional method of visual reading of seismograph traces against those who wished to make the process completely automatic. Some new blood from telecommunication and radio research has obviously been brought into the AWRE team, and it looks as if there will be some real advances in technique. There is one great advantage of automatic reading of records: the machine can be set to operate to an agreed set of rules, and arguments as to the interpretation of a particular squiggle on a record will be avoided. The machine will decide whether a particular event is an earthquake or whether it is of doubtful origin and therefore should be investigated further.

It is to be hoped that similar meetings are going on in the USA and Russia, and that Earth scientists the world over will take an interest in the prospect of working for peace. At the same time, of course, natural curiosity about the inside of the Earth will be satisfied. Professor Beloussov has suggested, for example, international cooperation in finding out about the upper part of the Earth's mantle. Apart from the Mohole project to sample the mantle rock, a great deal of information can be obtained by seismological studies. To make the best use of the information provided by earthquake waves it is necessary to have a more comprehensive network of recording stations than exists at present. Furthermore there is a need for newer equipment and some standardization of instruments.

The British Association led the world in establishing earthquake observations at the end of the last century. A little leadership now could produce another revolution in the subject. It is a good sign that the atomic energy authorities are encouraging experienced Earth scientists to cooperate with them.

May the High Dam be another plague of Egypt?

IT is extraordinary that in these times the consequences of a major engineering project should be in serious doubt. Nevertheless, the proposed High Dam across the Nile at Aswan has recently come under fire from experts predicting dire catastrophe for Egypt.

A few weeks ago, in two papers read at the Institution of Civil Engineers, A. A. Ahmed, formerly of the Egyptiaa Ministry of Public Works, attacked the whole concept of the High Dam. Its success or otherwise, in storing water from one year to the next to even out annual fluctuations, hinges on the importance of silt. The Dam's defenders argue that seepage losses of water into the underlying porous rocks are likely to be negligible because of silt blocking up the interstices. Dr. Ahmed, however, approached the question by comparing the history of silting of the present Aswan Reservoir with that likely to occur in the High Dam Reservoir built on the same rock formation. His startling conclusions were that the whole of the Nile discharge could easily be lost by seepage during the first twenty years of the High Dam's life; that the following ten years would show a deficit in Egypt and the Sudan of about 70 per cent of their present quota; and that only after this would these countries get a moderately increased water supply of some 20 per cent from the project.

In addition to this possibly devastating outcome of the scheme, considerable amounts of silt—a valuable fertilizer and soil-forming agent—would be checked by the Dam. The resulting clear water might undermine the permanent structure of the river by increased erosion.

Now, sharp criticism comes from a quite different direction—from a University of Michigan zoologist, Professor H. van der Schalie. He contends that the artificial lake, with its concomitant irrigation system, would form an ideal instrument for the spread of a schistosomiasis (bilharzia) epidemic. This disease is one of the worst scourges of the underdeveloped countries and already weakens many Egyptians to the point of being unable to work. The parasitic worm to which it is due lives for part of its life cycle in a certain kind of snail. Breeding grounds for this snail will be vastly increased in size as a result of the greater area of water checked by the High Dam. It is both difficult and expensive to control the snail and thus, until there is an effective public health programme, the agricultural land expected to be improved by the Dam may suffer a shortage of farmers to work it.

Notes and Comments *continued*

Natural gas development in the Soviet Union

THE present seven-year plan of the USSR lays special emphasis on the development of the gas industry and the increasing production of natural gas. The Russians appear to be acutely conscious of the elevenfold difference in natural gas output between themselves and the United States, and intend to make great efforts to reduce the disparity to a threefold difference by 1965.

For many years natural gas occupied a very minor place in Russia's total fuel resources. From 1940 to 1955 it grew from 2.0 to 2.6 per cent. A more rapid growth took the figure to 6.5 per cent in 1958. The seven-year plan is hoped to raise it to 21 per cent.

Until recently, prospecting for natural gas has been only incidental in prospecting for oil, but in the next five years it is planned to drill 15 million metres of deep prospect holes for gas alone. The resources already found and substantiated by geological data give grounds for planning the high rate of development.

The programme calls for large-scale automation in the gas fields, which will enable the number of personnel to be reduced by a factor of ten to fifteen. Capital investments in automation should be repaid in about five years. By 1965 automation will be used in about three-quarters of all the gas fields.

The major development problems are transportation and storage. The mileage of gas pipelines in Russia is growing much faster than gas output; since 1940 gas output has increased 8.7 times, while the pipeline network has extended almost 40 times, reaching this year 17,000 kilometres. The seven-year plan should see the addition of another 26,000 kilometres. Bearing in mind, however, the comparative (1956) figure for the United States of 716,000 kilometres, it seems that the Russians still have a long way to go.

The expense of transporting natural gas constitutes the greater part of the cost; it is 80 per cent for the USSR and 73 per cent for the USA. These costs are dependent on the engineering of the pipelines. For example, increasing the pipeline diameters from 72 to 102 centimetres cuts the delivery cost by over a third. Another method of reducing costs is to use plastic instead of metal pipes, and experiments are also being carried out with asbestos-cement pipes, which are corrosion-resistant.

The seasonal fluctuation in the demand for gas necessitates some kind of storage system. The most economical way of storing gas is to pump it into old, exhausted natural-gas fields. This is already being done on a large scale in the United States, and covers at least a third of the total requirements in the winter months.

In Russia the exhausted Bashkatov and Amansky deposits have both been used for storage, and work is going on near Moscow, Leningrad and Kiev on the exploration of porous strata that would lend themselves to storage. In the absence of exhausted gas deposits near these cities, it is planned to utilize water-bearing strata.

Chemical industry on view to careers masters

HOW can a schoolteacher tell his boys the facts of industrial life? This week sees an attempt by the British chemical industry to give careers masters an overall view of how it works. The Careers Masters' Convention, run by the Shell Chemical Company and the Public Schools Appointments Bureau, with the active cooperation of most of the great chemical companies, is an important step forward.

Groups of careers masters have been encouraged in the past to take fleeting glimpses of individual firms, and they are continuously deluged with literature from industry furiously competing with itself for the services of their charges. This week the chemical industry has taken the pressure off the sixty members of the convention. Instead it has given them a calm appraisal of the organization and function of the chemical industry in the course of four distinguished lectures, and has then taken them off to see for themselves.

The content of the course has been carefully planned to give as wide a view as possible. The visits have been to the research department of the Distillers' Company, to Shellhaven and Fisons' fertilizer plant at Stanford-le-Hope, and to the Technical Services Laboratories of the ICI plastics division. The schoolmasters have in fact learnt a very great deal—within the limitations that the establishments they have seen are among the finest of their kind and that many industrial chemists work in conditions considerably inferior to these.

Trapping the torrents of Baluchistan

THE Pakistan food problem has set a British irrigation engineer exploring, by bicycle and camel, the repellently barren hills of Baluchistan. He has been serving as a Food and Agriculture Organization expert advising the Government of West Pakistan about schemes for disciplining the numerous intermittent mountain torrents that flow into the right bank of the the Indus river. Large dams to store the torrent water could extend existing crop irrigation systems and control measures would safeguard the irrigation canals along the right bank of the river from the excessively destructive flooding which occurs, on the average, once every ten years.

In his report Mr. George Meade suggests that in the Peshawar region it would be feasible to conserve the waters of two of the major torrents by means of two interconnected dams. Hydraulic data on these torrents are now being collected as a first step towards possible implementation of the scheme.

Around Dera Ghaki Khan, where the torrents are more numerous and more destructive, the potential threat to cultivated land in the plains makes it necessary to plan for control as well as for utilization of the water flow. The costs of building flood control dams would be very high, but Mr. Meade suggests the creation of an enormous lake, by building up artificial earth walls, thus to hold back the peak floods. The actual spoil bank of the Dera Ghazi canal could form one wall of the lake. At another site, where a storage dam would quickly silt up, a troublesome torrent might be tamed by constructing a retarding dam to slow down the normal two-days' flood discharge, spreading it over a period of two weeks.

Mr. Meade is one of the first engineers to explore fully the numerous ravines of the region. The excellent maps of Baluchistan provided by the 1907 Survey of India proved a most helpful guide to this eroded and barren hill country.

Self-medication studies on a housing estate

IN spite of the National Health Service British pharmacists continue to sell large quantities of preparations for self-medication (perhaps £20 millions-worth a year) with the aid of advertising through the Press, radio and television. Dr. J. H. Robertson and his colleagues have collected some interesting information on the behaviour of the public in a survey

made by personal interview in a community living on a new LCC housing estate.

Admittedly the sample was somewhat restricted as those questioned were mainly skilled and unskilled manual workers, clerical workers and shop assistants. Such a community would consist largely of middle-aged persons with a greater number of children than in the general population.

The two commonest medicines which they take without medical advice are aspirin and laxatives. Aspirin, regarded almost as a panacea, is taken for such a wide variety of ills as rheumatism, backache, headache, coughs and colds, nervous trouble, bad teeth, insomnia and menstrual disorders. Laxatives are given regularly to 90 per cent of the children in the families questioned, but for preventive reasons and not to relieve constipation; 44 per cent of the adults took laxatives for the same reason. Next in order of popularity came tonics, sore throat tablets, indigestion remedies, eye lotions, embrocations and "rubs" for rheumatic pains and sprains, and vitamins.

Self-medication is not an alternative to visiting the doctor. In fact, Brotherston and his colleagues noted that those who dosed themselves frequently saw their doctors more often than those that did not. They were evidently the medicine-conscious section of the public. For the treatment of minor ills and aches and pains, reasonable self-medication does little harm. It relieves the pressure on the general practitioner, particularly in the winter months, and benefits the Exchequer by reducing the drug bill of the National Health Service.

New industrial uses for uranium?

THE Canadian Minister of Mines, Mr. Paul Comtais, announced recently that scientists in his department have found a method of alloying small quantities of uranium with steel, in the proportion of a pound of uranium to a ton of steel, to produce a metal with improved strength, high-temperature properties and resistance to corrosion. This could be done without a substantial increase in costs.

Research on the satisfactory alloying of uranium with steel has been going on at least since the first World War, and is at present also being conducted by the United States Bureau of Mines. If the Canadians have succeeded, this may well constitute a significant advance in metallurgy. A patent has been taken out, and future research will be carried on by

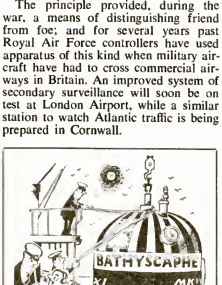
the Uranium Research Foundation, which has been formed by the Canadian uranium mining industry.

There has been a need lately to find new uses for uranium, because British and American orders have not been as large as anticipated, and the capacity for uranium production in Canada is far from being fully exploited. South Africa and Australia, also large producers of the metal, would also welcome a use for it in the steel industry.

Electronic "responders" on the airliners

IT will almost certainly not be long before airliners of Britain and the USA have to carry electronic "responders", now that the two Governments have agreed on the technical standards to be met by "secondary surveillance" radar. The responders are simple devices which, when triggered by a radar beam, automatically send out a signal designed to identify the aircraft.

The principle provided, during the war, a means of distinguishing friend from foe; and for several years past Royal Air Force controllers have used apparatus of this kind when military aircraft have had to cross commercial airways in Britain. An improved system of secondary surveillance will soon be on test at London Airport, while a similar station to watch Atlantic traffic is being prepared in Cornwall.



"He says it's too cold."

Secondary surveillance adds to the information derived from the normal radar watch, on whose screen a simple "blip" represents each aircraft within range of the scanner and affords the means of determining the height and range of the aircraft. Sometimes the controller needs more precise information; and these occasions will multiply as air traffic thickens and speeds increase.

Secondary radar can then be used by the controller either to improve his observation of a particular aeroplane's course and speed or to make sure that a particular aeroplane is in the position and at the height he believes. In the British system two kinds of response are possible. One simply makes the aircraft's blip on the screen bigger and brighter, so enabling the controller to pick it out and track it among all the other blips; the second is an act of self-identification, in which the transmission from the aircraft's responder puts an extra blip alongside the original one on the screen.

This system is capable of development so that an actual code, giving identifying letters, could be transmitted by a responder, but no plans have yet been made to that end. For the present, assurance that the aircraft under observation is not being confused with any other in the neighbourhood will add greatly to control efficiency. By doing it in this way, with automatic devices, time will be saved and what an airways captain the other day called "the babble on the radio" need get no worse.

Captains will still have to be told what to do by the controllers, but there will be less need for passing position and height reports over the radio. Anglo-American agreement on standards for secondary radar will not mean uniformity of apparatus (a British and an American set have been developed), but it will define the requirements so that responders will answer in both systems. There is little doubt that the operators of other nations will resort to similar equipment.

A new experiment for an old Polar explorer

NEWS of a septuagenarian in the Antarctic on a scientific mission may startle younger men, even in these days of air travel and relative comfort. In the present instance, however, the explorer is no stranger to the rougher aspects of polar life. Fifty years ago Sir Charles Wright was a member of Captain Scott's ill-fated expedition to the South Pole—in 1912 he guided the search party which found the bodies of Scott and his companions. During the second World War

Notes and Comments *continued*

he was chief of the Royal Naval Scientific Service.

Now at 73 he is putting together apparatus to study "whistlers" at Byrd Station, near the South Magnetic Pole. A whistler is a low-frequency radio signal caused by a lightning discharge: it has the property of bouncing backwards and forwards like a shuttlecock from one hemisphere to another along a line of force in the Earth's magnetic field.

Both Sir Charles and his colleague, D. J. Evans, are attached to the Pacific Naval Laboratory, Esquimalt, British Columbia. L. H. Martin, a New Zealand scientist at Stanford University, with another team from the PNL, is setting up this month a second radio detection station at the northern end of the 100,000-mile line of magnetic force. This will be on the Great Whale River, Hudson's Bay, close to the North Magnetic Pole.

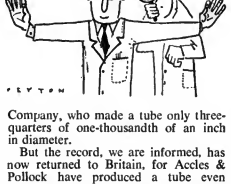
Each of the whistlers originating near to these observation posts may echo up to 25 times between them. The lines of force reach about 30,000 miles upwards into the sparse atmospheric regions known as the exosphere. The participants expect the experiment to reveal more about this region and its degree of ionization. In this respect it will add to information gained from satellite observations.

The Antarctic party is to detect radio waves in the very low frequency range. The northern scientists, although their equipment overlaps part of this range, will study rather more rapid waves. Previous work on whistlers has largely neglected the low frequency part of the spectrum, and this experiment is significant because it is just these radio waves which are able to pass through the ionosphere, 60 miles above us, without being reflected.

World's smallest tube: record intact

ONE of the classic stories of Anglo-American engineering rivalry is about the American firm that sent a sample of "the world's smallest tube" across the Atlantic. It was returned with an Accles & Pollock tube threaded inside it. That was nearly forty years ago, and since then precision tubes have got progressively smaller as techniques have improved.

Now, however, the Americans have tried to get their own back. In the new edition of the ever-fascinating *Guinness Book of Records* the old entry for the world's smallest tube, which gave the credit to Accles & Pollock with a tube only one-thousandth of an inch in outside diameter, has been revised in favour of an American firm, Superior Tube



Company, who made a tube only three-quarters of one-thousandth of an inch in diameter.

But the record, we are informed, has now returned to Britain, for Accles & Pollock have produced a tube even smaller than the newest American claimant. It has an outside diameter of .000733 inch and the diameter of the bore is .0001 inch. This newest version of the world's smallest tube is only a quarter the thickness of human hair. One hundred and twenty miles of it would weigh only a pound. Such tubes are made for the sake of developing the techniques of tube making; but they do find occasional applications—for example, in experiments on the artificial insemination of Queen bees.

A few years ago a visitor to the Accles & Pollock Oldbury works remarked that they seemed able to do everything to tubes except turn them inside out. What was intended as a compliment was taken as a challenge, and Mr. W. W. Hacket, veteran president of the company, got to work with some of the firm's development staff and showed that they *could* turn tubes inside out. One was sent as a present to the visitor who had made the remark.

Some time later a university professor, visiting the works, was told the story and shown a tube turned inside out for half its length. It proved to be just what one university department needed as a seamless vacuum flask for research work at temperatures near absolute zero—and what had started as a joke became a new product.

"Don't you think we should have a third opinion?"

Mincing words about the Rhodesian slaughter

THE annual reports of government game departments are usually a curious mixture of official euphemisms and implied but unanswered questions. They give the impression that animals are never shot or destroyed: they are "culled", or at worst their numbers are "curtailed" or "reduced". At times this sort of language can get unpleasantly near the truth. The current report of the Department of Game of Southern Rhodesia talks, for instance, of the elephant "wastage" during the year under review. This amounted to some 430 animals. But when the administration goes on to say that as the number of elephants destroyed "falls short of natural increase" and the rate of destruction in the future "will have to be stepped up", an outsider is left with the impression that the careful harvesting of elephants would be more profitable than the expensive ranching of fly-blown European cattle, with its catastrophic effect on the native fauna.

Similarly, the report speaks of the successful "spraying" of the Quelea finches on the Chipangayi nesting site of about 109 acres. Now this finch-like bird is an undoubted pest, congregating in locust-like numbers and ravaging rice and other crops. But with what was it sprayed? The answer seems to be parathion and burning paraffin from flame-throwers. But all that can be learnt is that "some millions" of birds were destroyed. More information is obviously needed.

The most paradoxical part of the whole report relates to Operation Noah, the animal rescue service set up at Kariba in the flooded Zambezi valley. It has been estimated that at most some four or five thousand animals were "saved" in this operation. (The quotation marks around "saved" are necessary because nobody yet knows what happens to an animal that is forcibly introduced into a new habitat.)

During the same period when a maximum number of 5,000 animals were saved, the Department of Game in one year shot more than three times as many (18,583) in tsetse fly control measures. This brought the grand total of native animals destroyed in the tsetse campaign to 678,187. This figure includes approximately 6,600 buffalo, 9,200 zebra, 10,200 eland, 88,000 kudu, 37,000 sable antelope, 193,000 duiker, 54,000 baboon, 21,000 bushpig and about 500 leopard. Might it not be more profitable from all points of view to dispense entirely with the Department of Game and establish a local conservation unit?

Towards giant space vehicles

With increasing size of rockets and improvements in propellants, it can be accepted that the launching of a space vehicle as heavy as Comet aircraft is within sight. Moon surveys by a passenger, and ultimately human landings, are probable during the next ten years

by Professor A. D. Baxter
de Havilland Engine Co. Ltd.

TEN years ago very few people had much belief in the prospects of firing rockets into space, and even five years ago, when the USA and the USSR announced their intentions of launching Earth satellite vehicles, both projects still seemed slightly fantastic. It is now a little more than three years since the Russians put the first artificial satellite into orbit, yet development has proceeded at such a pace that no longer does anyone wonder at space vehicles, but only at what the next success will be. The Americans have always publicized their future intentions and, although success has not always come at the first attempt, they have been following a definite programme. From time to time the programme has been revised in an effort to keep abreast of the Russians, but this does not affect the objectives. On the other hand, the Russians have generally left the world in ignorance of their plans until their successful achievement. Occasionally they have allowed themselves to hint at future developments, and recently one such hint from Khrushchev himself implied their readiness to launch a 60-ton space vehicle.

This is almost the weight of a Comet aircraft, and nothing approaching it has yet been launched. Can we believe it is real and, if so, what are its implications for the future? To decide these points it is necessary to review the available evidence and make some assumptions on technical progress.

Present Achievements.—Figure 1 demonstrates the growth in space vehicle payloads during the past three years for both Soviet and American rockets. It will be seen that these have increased by two orders of magnitude in about two and a half years, and one more order of magnitude would bring the Russians close to the 60-ton mark. The curve would, however, need to take a sharp change in rate of increase if this very large payload were to be achieved in the near future. On the other hand, the Americans have been lagging nearly an order of magnitude behind the Russians or, in terms of time for the same payload, one to two years. This continues into the future, for it will be seen that the next big American step planned is the launching of *Centaur* in 1961. This will probably have an initial payload of 8000 lb and later 10,000 lb. The follow-up to this will not be until 1963, when *Saturn* will provide payloads of 20,000 to 25,000 lb. Still farther into the future is the giant *Nova*, which is being planned for 1967, with payloads approaching 50 tons.

A programme of this nature appears to be a logical development, and we may argue from it that an immediate Russian satellite of this weight seems very unlikely. In the past such scepticism concerning Russian claims has been quickly dispelled by the results. There is, however, one difficulty in assessing and comparing payloads. In aircraft practice payload is the useful load delivered, such as cargo or passengers. In satellites this would correspond to the instruments, animals or useful equipment placed in orbit. To carry such equipment a container must be provided, and it is usually accepted as part of the payload. In turn this container is carried by the final stage rocket which will, at the end of its propulsive effort, have entered the orbit as part of the satellite. All this dead weight is sometimes added to the useful weigbt and this may result in a misleading figure. In tbe case of *Discoverer I*, for example, the total weight in orbit was 1,300 lb, but only 245 lb was instruments. Similarly, *Project Score* was claimed as a record weight satellite. It was launched in December, 1958, using the *Atlas* inter-continental ballistic missile as its booster. The initial weight was about 244,000 lb, and its three thrust chambers gave a take-off thrust of 360,000 lb. The whole of this rocket, apart from the propellant consumed en route and two thrust chambers discarded during the climb, eventually went into orbit weighing 8,750 lb. Of this only 150 lb was useful instrumentation. Incidentally, the structure was approximately 85 ft long and 10 ft diameter. This is of particular significance in comparing with *Sputnik II*, which was estimated from various ground observations to be about 80 ft long. It contained tbe dog Laika and was stated to weigh 2,000 lb, of which 1,120 lb was payload.

Technical Progress.—Several questions spring to mind after examining the results achieved so far. The first is, obviously, how

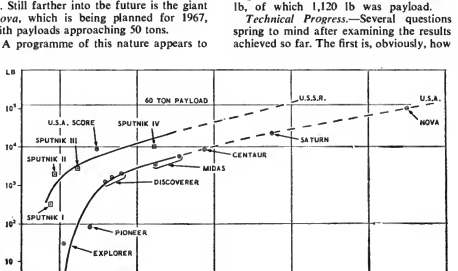


FIGURE 1. *Increase in satellite payloads.*

Towards giant space vehicles *continued*

have the Russians succeeded in getting ahead of the Americans? The second is bow bave the present advances been made? And a tbird is what can be expected in the future? Tbe answers must be largely surmise, but the principles involved are quite definite and an examination of them will give significant pointers.

A payload is put into orbit by accelerating it to a sufficiently high velocity, of the order of 26,500 ft per sec. A rocket will produce a velocity given by the formula

$$V = v_j \log_e \frac{W_A}{W_E}$$

where v_j is the rocket exhaust jet velocity, W_A is the all-up weight at the commencement of firing, and W_E is the empty weigbt at the conclusion of firing. W_A consists of payload P, propellant W_P and structure W_S, while W_E is payload and structure only. The ratio $\frac{W_A}{W_E}$ is referred to as the mass ratio.

Generally the practical values of tbese quantities are not sufficient to produce orbital velocity in a single stage, but the drawback is overcome by the use of several stages, as shown diagrammatically in Figure 2. In this, the first stage (W_{A1}) is sufficiently large and powerful to launch and accelerate the second and subsequent stages to some velocity V_1 before all its propellant is used. At this point its empty tanks, engine and structure (W_{s1}) cannot help further and are discarded, leaving a smaller mass (W_{A2}) for the second stage to accelerate from V_1 to V_2. Tbe second stage structure (W_{S2}) is then discarded in its turn, leaving a still smaller mass (W_{A3}) to continue to V_3. Ultimately, tbe satellite weight P reaching orbital velocity will be only a small fraction of the original launching weight.

If it is assumed that the mass ratio of each stage is the same and that the structure weight of each stage is a constant fraction of the corresponding stage payload, the effect of this dead weight on the satellite weigbt can be seen in Figure 3. Thus, if a stage mass ratio of four is necessary witb a three-stage rocket, the satellite payload will be approximately one five hundredth of the initial launching weight. Reducing structure weight by 50 per cent in each stage will increase the payload to nearly 240 per cent, and a further reduction of structure weight to 25 per cent will put up the payload to 500 per cent.

Figure 3 also shows that if tbe necessary orbital velocity could be reached with only two stages and the same mass ratio, the payload would vary from 800 per cent to over 2,000 per cent according to the structure weight.

Reference to the basic rocket performance formula indicates that this improvement could be achieved only by an increase in the rocket jet velocity which, in turn, depends upon the propellants. If the standard propellant permits orbital velocity being reacbed with a three-stage rocket having stage mass ratios of 4, then a propellant whicb was 25 per cent better would give the same result with stages having mass ratios of 3. This change in mass ratio permits a greater proportion of the all-up weigbt to be in tbe form of payload. A further improvement in propellants would allow a cbange to two-stage rockets, and the case quoted above would need a 50 per cent better propellant.

So far tbe figures have shown that payload percentage can be improved by either skilful engineering in reducing the percentage weight of structure or by introducing more powerful propellants. A third possibility which can be combined with tbese or remain independent is to build larger launching vehicles. To some degree it is possible to scale up the weights and so increase the absolute payload. Alternatively, multiples of a given unit can be combined to form a much larger single unit.

Practical Progress.—Figure 4 indicates the growth in launching weight of American satellite vehicles from the modest 22,600 lb of *Vanguard* to the 265,000 lb of *Midas II*, and from the proposed weight of more than 1,000,000 lb of *Saturn* to the 4,500,000 lb of *Nova*. To match these launcbing weights rocket engine thrusts have also increased, and Figure 4 includes this development. Generally the thrust required is about one-third greater than the launching weight and as this can be provided by multiple chambers, the growth in single chamber thrust has been less spectacular than that of vehicle weight until recently. At any given time the multiple chamber thrust has been about twice that of the single chamber although more than two chambers have been used. This is because multi-chamber development must lag a year or two behind that of the single chamber. Equally, the satellite launcher lags some years behind both.

From these curves it is clear that, at least in part, the increases in rocket size account for some of the increased payload already achieved and proposed in America. Payloads have, however, increased much more in proportion, and so it is clear that other technical developments have assisted. It is probable that operating experience and new construction techniques have permitted reduction in the deadweight of each stage. In the early satellites, each pound of payload was accompanied into orbit by something between one and two pounds of final stage empty rocket. Tbis was reduced in later shots so that the ratio of structure weight to payload dropped to about 66 per cent. This, as shown in Figure 3, will have a considerable influence in increasing payload.

Finally, improvements in propellant performance have been occurring. The early rockets used liquid oxygen and kerosene which gave exhaust jet velocities, v_j, about 8,000 ft per sec. Other fuels may be better because they contain more hydrogen. One such, referred to as Hydyne, was introduced to the second stage rockets and gave about 5 per cent improvement in velocity. Later, pure liquid hydrogen has been introduced and motors up to 20,000 lb thrust will be incorporated in *Centaur* and up to 200,000 lb in *Saturn*. This will improve propellant performance by more than 30 per cent and, in the case of *Centaur*, permit the use of two stages only. The marked effect of this on payload can be seen in Figure 3.

Future Possibilities.—As already noted, the Russians appear to be about two years ahead of the Americans and it can be presumed that they have developed their

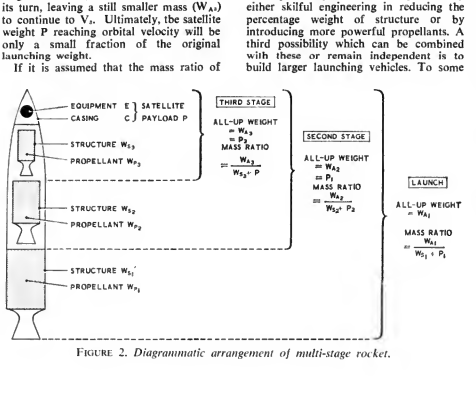


FIGURE 2. *Diagrammatic arrangement of multi-stage rocket.*

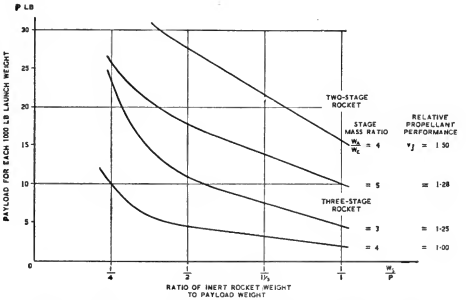


FIGURE 3. *Effect of structure weight and propellant performance on payload*

rockets along broadly similar lines. The first of these was undoubtedly to build larger engines and launching vehicles. Their *T-3A* inter-continental ballistic missile is reputed to have a first stage thrust of 700,000 lb which, by comparison with American figures, suggests a satellite launching vehicle of 500,000 lb and a payload of 15,000 lb. In fact, launching weights may exceed these figures by a large margin, and payloads of 20,000 lb at this time would be in line with the curve drawn in Figure 1.

This superiority may have been brought about by the fact that the Americans had discovered, relatively early, that a nuclear warhead could be built much lighter than originally anticipated. Without this knowledge a much larger rocket would have been required for ballistic missiles. This is indicated on Figure 4 by the *Navaho* and *Atlas* rocket engine specifications in 1951 which were cancelled. If the Russians were proceeding on similar lines and continued, they would have gained an advantage in experience with large units due to their ignorance in other directions. Apart from size, it is possible that they are ahead in exploiting both lighter structure weight and improved propellants. The fact that *Sputnik II* had a final stage structure about 80 ft long accompanying it in orbit certainly suggests this.

It is, therefore, possible to accept that a rocket vehicle large enough to place a weight of more than 100,000 lb in orbit is within sight. Such a load would be more than adequate for putting a man into space and safely returning him to Earth. It can be regarded as the forerunner of Moon surveys by a passenger and ultimately human landings. These are already within the long-term American plans and must also be a part of Russian aspirations. The evidence suggests that there is every prospect that these ambitions will be fulfilled during the next decade. Thereafter deep space voyages will open up a period of exploration and resultant beneficial developments quite beyond our present conception.

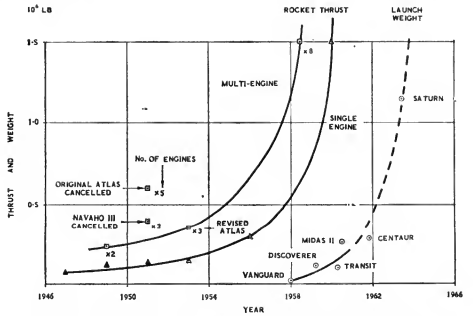


FIGURE 4. *Development of rocket engine and satellite launching vehicles sizes.*

Britain's backwardness in higher education

Professor Lord Robbins is to be chairman of a Committee appointed by the Government to advise whether any changes are desirable in the pattern of full-time higher education in Britain. That changes are urgently necessary, and that they must be very drastic, is the theme of Dr Bowden's outspoken article

by Dr B. V. Bowden
Principal, Manchester College of Technology

A RECENT statistical survey has shown that the British economy is expanding more slowly than that of most other European countries. On the assumption that the gross national product per head was 100 in 1950, Western Germany has now reached 171, the OEEC countries average 139 and the United Kingdom only 122; and this despite the fact that the proportional rate of investment per worker in this country has been quite high during the last decade. It is clear that our investment has not been as productive as it should have been; I believe this may well be due to the inadequacies of our educational system.

At long last the Government seems to have taken fright. Professor Lord Robbins's Committee is to study "full-time higher education in Great Britain in the light of national needs". Royal Commissions have studied our educational system, and universities in particular, ever since 1850. The universities owe much to Royal Commissions; some of their findings and those of independent observers a hundred years ago might be reissued today as tracts for the times; they might even form part of the report of the Robbins Committee.

The Industrial Revolution in England owed very little either to our schools or to our universities, but Continental governments always expected their educational establishments, and particularly their great technical universities, to help the development of local industries. Abraham Lincoln established the Land Grant Colleges in the middle of the Civil War; Congress endowed these new foundations with 17 million acres of land, hoping that they would do as much for America.

Matthew Arnold investigated conditions on the Continent in the 1860s. He found that Swiss and German engineers were much better educated than ours, and maintained with heat and bitterness that unless we improved our schools and universities so that our young people had a chance to compete with their contemporaries, our prospects as a manufacturing country were gloomy indeed.

Our universities then complacently assumed that they were the most important centres of learning in the world, but this view was not shared by European scholars, some of whom said flatly that the University of Oxford should not rank as a university at all—but only as a "superior high school". Fifty years ago Oxford's Chancellor (Lord Curzon) reported that his University "could not hope to emulate a University like Harvard", and an English ironmaster complained to Andrew Carnegie, "It is not your wonderful machinery, nor your unequalled supply of raw materials that we have cause to envy—it is something worth both of them combined. The class of young scientific experts who manage every department of your works. We have no such class in England." When the new Committee has completed its inquiry, will Mr. Macmillan, who is Chancellor of Oxford today, be more optimistic than Lord Curzon was in 1909?

I do not see how anyone can deny that far too many of our young people leave school and stop learning much too early in life. Comparisons between countries are often misleading, because universities differ in size and function from country to country, and standards differ from place to place even in the same country. Nevertheless, however much allowance one makes one is forced to conclude that the number of twenty-year-old full-time students is proportionally much less in England than it is in most other Western countries. Figures compiled by UNESCO suggest that the number of university students per million of the population in England is the smallest in Europe. In 1900 we had fewer universities in proportion to our population than any other country in Europe except Turkey. In the middle of the last century, when England was the workshop of the world and became fabulously rich, her people were among the most illiterate in Europe. We ought to know how we compare with other civilized countries today. We must not be ashamed to learn from other people.

Most of our great engineers in the last century were schooled by experience or in the Dissenters' Academies. They were never worried by that reverence for the past which haunts our society today. They never exalted the word above the thing. They knew (with Dr. Johnson) that "if words are the daughters of Earth, then things are the sons of Heaven". The pattern of world trade is changing fast. The rapidly growing industries all seem to be based on modern science. We can no longer hope that self-taught Englishmen can compete with well-educated foreigners.

Sir Geoffrey Crowther has described the situation as he sees it today; he thinks that we are in an educational rut: unless we bestir ourselves we shall gradually fall behind our industrial competitors; if our inadequately manned industry fails us, our society will die with a whimper if not with a bang.

Many commentators have applauded his analysis, but *The Times* remarked that "there is no sufficient reason to pack the universities until they burst, on the pretext of a state of emergency which is asserted but not demonstrated to exist". Does anyone still believe that a university education should be the prerogative of a leisured class and dislike the idea that

Lord Robbins, whom the Government has appointed as chairman of a Committee to inquire into higher education, is 62; he has been Professor of Economics in London University since 1929. Earlier he lectured at Oxford University, and he has published many works on economic science. During the war he directed the Economic Section of the Offices of the War Cabinet.

Other members of the Committee have not yet been announced. Its terms of reference are "to review the pattern of full-time higher education in Great Britain and in the light of national needs and resources to advise Her Majesty's Government on what principles its long-term development should be based. In particular, to advise, in the light of these principles, whether there should be any change in that pattern, whether any new types of institution are desirable and whether any modifications should be made in the present arrangements for planning and coordinating the development of the various types of institution."

"Heaven might be crammed"? *The Times* doubted the existence of a vast, urgent, unsatisfied demand for the services of graduates and felt that more should be done for highly skilled craftsmen. No one can or should dispute the need for more craftsmen, but in these days of rapid technological change, a skilled craftsman may find himself unemployable in later life as his craft loses its importance. All our industrial competitors use more graduates than we do. Has a university education no value here as a preparation for life?

Some of our universities (and Government research stations too) give one the impression that they would like to be as independent of the man in the street as the medieval monasteries were before them; spiritual pride is insidious. "Pure research" and "pure scholarship" are all important, but they can become excuses for complacency and indifference. The universities have a function as part of society. It is not enough for them to exist as places of beauty in which dons have beautiful thoughts; they must not be content merely to criticize our industrial society and refuse to help it. They must do what they can for thousands of young people who want to be educated. It is not for them to refuse to modify their traditional practices and procedures and send our youngsters away empty-handed. American universities usually seem to be more clearly aware of their place in society and accept their obligations to the community more willingly than ours do.

Most of our students graduate in three years; no other country expects its students to qualify so quickly. University courses abroad may last four, five, six or even seven years for a first degree. How do our graduates compare professionally and culturally? No other country allows its students to specialize early in their school life. Our students are better prepared to begin their professional studies when they start at university than their contemporaries abroad, but they have had less general education. No other country restricts the education of professional men so narrowly. Is this a healthy sign? I believe the Crowther Report dismissed the problem of sixth form specialization far too easily, and since the preparation of university students is very much the concern of the universities themselves, this problem should be studied again in the light of contemporary practice abroad.

One can form some estimate of the importance which a country attaches to education by the amount of money it spends on it. Obviously this is an imprecise yardstick, but it can be used in a preliminary survey. Why is it, for example, that we spend two and a half times as much on defence as we do on education, whereas the Russians spend about as much on education as they do on defence—perhaps sixteen times as much as we do? Is it true, as I believe, that although the Dutch spent about as much per head as we do on the education of young people up to the age of eighteen, they spend twice as much as we do in this country on the education of people over eighteen? Is it true that the Germans are spending much more than we are on their universities? Why do we spend no more on our universities than we do on the egg subsidy—perhaps half as much as we spend on atomic energy in Harwell and its associated laboratories?

The State of California alone is spending about $360 million a year on its universities and colleges, much more than all the English universities put together. It is planning to spend $1,000 million on new university buildings by 1970. The best Californian universities are among the best in the world. The University of California itself has 48,000 students who are taking four-year courses, but there are other enormous colleges which do not try to achieve the same intellectual standards; they are satisfied with work which was accepted in Oxford and Cambridge thirty years ago. They are not designed for the ablest 5 per cent of the population, but for the 15 per cent immediately beneath them, and 65,000 students attend three-year college courses, and another 100,000 are taking two-year courses in Junior Liberal Arts Colleges. Such courses are invaluable for students who could not aspire to an honours degree.

Men who took third or fourth classes or pass degrees in England thirty years ago enjoyed university life and profited from it. They were valuable members of the universities, and many of them have since become famous. Few of them would

Britain's backwardness in higher education *continued*

get university places today, for almost everyone who goes to a university is expected to read for an honours degree. Some dons have said that the expansion of our universities should be restricted so that they can exclude all but the very ablest men. They fear that their intellectual standards may suffer; but the pass men in Cambridge never interfered with Part III of the Mathematical Tripos. We have always done our best for brilliant students. It is vitally important that we should do so, for they will provide our leaders and pace-makers; but surely, as Abraham Lincoln remarked, "The Almighty must have liked the common people best, because he made so many of them". Our educational system must help to bring them to maturity and make them into responsible citizens of the new age, for upon them and their exertions the prosperity of the country must in large measure depend. It is monstrous that they should be refused admission to universities which were glad to accept such men in days gone by if (and only if) their parents could pay for them. Should we build Junior Colleges and Liberal Arts Colleges for them?

The Robbins Committee will have to make proposals for the future development of the advanced teaching of science and engineering in this country, a problem which is tremendously complicated by the competing claims of teaching and research, both of which are essential to healthy university life.

To what extent should the universities be used by the Government as their agents for the organization of research and development? In this country most research and development is done in Government establishments, such as the Royal Aircraft Establishment in Farnborough, or the Royal Radar Establishment in Malvern, in research associations which are organized by and through the Department of Scientific and Industrial Research, in such places as the Atomic Energy Authority in Harwell, or in industry itself. Universities tend to confine themselves to fundamental research and research schools are relatively small.

The American Government uses universities as agents to administer much of its research programme, and the American Universities have been revolutionized in the last fifteen years by the immense growth of their graduate schools. Massachusetts Institute of Technology has about 3,000 graduate students; English universities awarded 1,309 higher degrees in science and 466 in technology last year. The American Atomic Energy Commission undertakes very little research itself; most of it is organized by, and through, the universities. The University of California administers the laboratories in Los Alamos and the University of Chicago those in Argonne. The California Institute of Technology studies and develops jet engines as well as the great telescopes on Mount Wilson and Mount Palomar. MIT (which alone has a total budget of about $60 million a year for research and development—more than all the English universities put together) undertakes research for the Government in many fields; for example, the inertial navigational devices used by American submarines were developed there. America has achieved a most intimate association between the universities, contemporary research and industry, to the enormous benefit of all concerned.

On the Continent a very different organizational process produces a similar intimate intermingling between research and development. In Germany the Max Planck Institutes, which are separate from the universities, are very closely associated with them, and senior scientists and engineers are members

of staff both of the Max Planck Institutes and of the universities themselves. Furthermore, some of the laboratories which in England would be organized by Research Associations are situated in the universities and are inextricably mixed up with them. This is true, for example, in Aachen, in Delft and in Stockholm. To give one specific example, the main Swedish research centre for paper and pulp manufacture is on the campus of the Technical University of Stockholm.

In England contacts between universities and large-scale research centres seem to exist only by chance and as a result of the individual efforts of university professors and research workers. I believe that both the universities and the research associations suffer very much from this separation, and I think the Committee should inquire into the possibility of forging much closer links than now exist between such places as the National Physical Laboratory and London University, between the National Engineering Laboratory in East Kilbride and the University of Glasgow, and between the DSIR establishments and the universities which happen to be near to them. Most important of all, there should be much closer links between universities and industry. I think things are better now than they were. They could be improved even yet. I believe in particular that eminent scientists or engineers who work in research stations and industry should be appointed as part-time professors. One-third of the professors in the new technical university of Eindhoven are Professors Extraordinary, including the chief designer of the local motor car factory and the head of the organization and methods department of the Philips Company.

If more universities are to be built, I think they should be sited where large Government research stations can sponsor them and help them to grow. A university in York or in Norwich will find it extremely hard to recruit good scientists and engineers unless and until adequate and expensive research facilities have been provided. In either of these very beautiful cities it will be possible for members of the chapter of the local cathedral to take an interest in university affairs—but how much better if a university could be put near Malvern or near Farnborough, so that the vast resources which have been established there over the years, and the very able men who live there, could play a dual role like their contemporaries abroad and be both educators and research workers. The students would become aware of the importance and excitement of fundamental work which is undertaken on a large scale with a sense of urgency and with the best apparatus that money can buy.

The Committee must determine the size and number of new engineering schools in this country. It would be a fatal

mistake to spread our resources too thinly. Both the Germans and Americans assert that the minimum size at which such an institution becomes really efficient is very much larger than the largest school in England. The Germans believe that a technical university needs about 100 professors and 10,000 students. Aachen has been developed on this assumption since the war, and Charlottenburg is even bigger. Perhaps in the end we may decide to establish in England a full-scale technical university and very belatedly to follow the example of all the other industrial Western powers which have relied on such establishments to educate their engineers and technologists for a hundred years or more. Lord Cherwell urged the Government to do this in 1947. He may have been right.

To summarize, the Committee must consider what is to be done for the vast majority of students who now leave school at fifteen. Only one child in eight stays at school until the sixth form. We are at present planning to provide a university education for about 5 per cent of the population in 1970. Is it desirable, is it possible, that we should produce in this country what are effectively full-time educational facilities up to the age of twenty-one or so for perhaps 25 per cent or 30 per cent of the population? Would such a policy materially improve the economic position of the country, or are all contemporary Western countries wrong in thinking that it does? Alternatively perhaps, are they right in thinking that a university education for a substantial minority is a good thing in itself? Are we still worried by the fear of a Manchester business man, who told me that "if all the clever boys go to college there will be no one to employ the graduates"?

We should not be too proud to learn from the practice of our most progressive competitors and model our own policy on theirs.

If a large increase in educational facilities is necessary, how are our schools of science and engineering to be built? How will the students learn their science in secondary schools—where are the science masters to come from? Is it possible that university departments can be built or should be built without a much closer liaison between universities, Government research establishments and industry? If such an association is necessary, as I believe it to be, how best can it be achieved?

Now that I have gone so far towards getting myself publicly stoned, I feel I can add with impunity that I believe that the lecture system which many universities have used ever since the Middle Ages is an anachronism: wasteful, inefficient and indefensible. No one, except advertisers and variety artists, has attempted to exploit modern media of mass communication. How effective can films, television and other aids become? How successful have American experiments been? Could we learn anything from any of them? We all like and admire the individual contacts which the tutorial system provides, but should we deny tuition to millions in order to preserve our present system for a few thousands?

If Lord Robbins can answer these questions satisfactorily and if the Government will then *do* something, we shall make history.

The search for a chemical "scarecrow"

The idea of treating crops with a chemical which would repel birds is being explored by studies of the sense of taste in birds and tests designed to show their preferences or dislikes. Fowls and pigeons, unlike mammals, appear to be indifferent to sweetness

by Dr C. J. Duncan
Department of Zoology, University of Liverpool

BIRDS, for all their attractiveness, can be a dreadful nuisance, as any gardener who has lost a row of peas or his cherry crop will agree. In suburban gardens blackbirds, starlings and house-sparrows are the chief offenders, but wood-pigeons and jays are additional enemies in rural areas. In agriculture and horticulture bird damage is more serious, particularly that done by wood-pigeons to field peas and brassicae.

Gardeners and farmers have used many defences against these attacks on their crops—including black cotton, the conventional scarecrow, "super-scarecrows" such as models of hawks rotated at the end of a nylon cord from the top of a pylon, and different types of "bangers" exploding at intervals. The last-named method, using such mechanisms as acetylene generators with detonators, is the mechanical development of the practice in Africa and Asia of using drums and other means of producing loud and sudden noises to scare the birds.

Some success was recently claimed for the device of recording the distress call of a particular species and relaying it back to flocks of the birds by loudspeaker systems: a method which might be most useful for clearing birds from their roosts in food stores and cities, where their excreta is unsightly and adds to the expense of cleaning buildings. However, the effectiveness of any known "scaring" device decreases with time, since it includes no form of punishment and the birds rapidly become habituated.

Nest destruction schemes and nationally organized shooting campaigns are among methods by which attempts are being made to exercise direct control over the wood-pigeon population; but, to be effective, such measures are expensive, both in money and in man-hours.

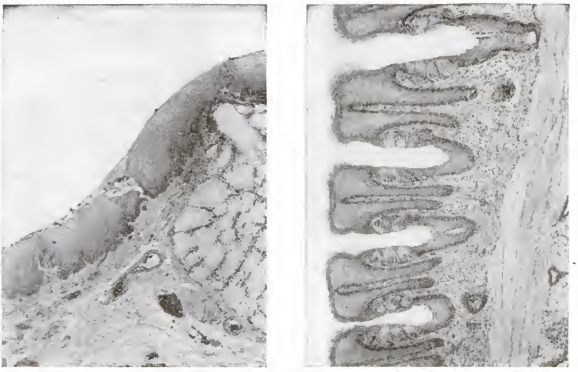
The idea of treating crops with a chemical which would repel birds is theoretically attractive, and would be of special value for the protection of seeds and fruit buds. Bullfinches are a particular enemy of the fruit-grower. Since each bird can destroy the buds at the rate of 30 per minute, a flock can cause a great deal of damage, the trees and bushes being vulnerable for much of the winter and spring. During this time the diet of the bullfinch consists mainly of tree buds, and in severe cases of damage over several seasons such trees may become malformed. An efficient repellent substance would have to be harmless to the plants, to Man and to all wild life. It would have to be prepared in such a form that it would adhere to the crops or seeds for the period that protection was required and not be washed off with the first shower of rain. The major requirement, of course, is that it should repel hungry birds. If such a substance could be produced and applied as a spray or dust, damage would be prevented without killing or harming the birds—such species as the bullfinch would simply be forced to return to their original food in the hedgerow.

Repellent chemicals can act on the sense of taste, smell or touch, but most experiments with birds have used substances which are expected to act on the sense of taste. Here we have been at a disadvantage since relatively little is known of this sense in birds, and there is no reason to suppose that it resembles that of Man. For this reason, the Land Pests branch of the Ministry of Agriculture, Fisheries and Food began a programme of research which has been amplified at the University of Liverpool, aided by the Agricultural Research Council.

The sensory receptors in the tongue are ovoid clusters of cells termed taste buds. There are about 9,000 such receptors in Man and 20,000 in cattle. When suitably stimulated the taste buds, modified by information from the touch, temperature and olfactory sensory systems, produce sensations of taste. Only a few species of birds have been studied so far, but in all of these the total number of taste buds is very small, usually fewer than 50, and they are confined to the back of the tongue.

We might easily conclude from these anatomical facts that the sense of taste is rudimentary in the birds studied; but this is not necessarily true. For a long time tastes have been classified by Man into four main categories or modalities—salty, sour, bitter, and sweet. Salty substances owe their taste to the presence of the chloride ion, while acids characteristically taste sour. A typical bitter taste is that of quinine. The sensation of sweetness, although generally associated with sugars, is produced by a variety of substances. When the taste buds are stimulated by chemicals, nervous impulses are generated in the nerves supplying the tongue, and in this way coded information of the nature of solutions in the mouth is transmitted to the brain.

Workers in Sweden, using biological amplifiers and oscilloscopes, have been able to investigate and analyse this traffic of nervous impulses, after stimulation of the tongue of pigeons and chickens by various solutions. In both species a discharge of nervous impulses followed the application of salt or acid solutions, indicating that the taste buds were sensitive to these modalities. The chickens gave a positive response to quinine but not to saccharine, whereas 50 per cent of the pigeons did respond to saccharine but none produced a nervous discharge when stimulated with quinine. Neither species, however, responded to the sugar sucrose. The sensitivity to the modalities of bitter and sweet, therefore, differs from that of mammals, and differs also between these two species of birds.



Photomicrographs of taste buds—left, on a pigeon's tongue (× 110) and right, on a rabbit's tongue (×100).

The results of these electrophysiological experiments provide us with information about the tastes which birds can detect, but tell us nothing of their preferences or dislikes. This aspect of taste investigation has been studied by carefully controlled preference tests. Although various methods have been used, all attempt to compare the acceptance of a solution of known concentration with that of water, the standard yardstick. On this basis, pigeons "prefer" salty substances in dilute solution, but at higher concentrations rejection becomes more and more marked. The pattern of response agrees closely with the results obtained from similar experimental studies on rats. The birds showed a marked aversion to sour-tasting solutions, the response again corresponding with that shown by mammals.

Here, however, the similarity between these two groups of vertebrates ends. Unlike mammals, both fowls and pigeons seem, in general, to be indifferent to solutions of various sugars; there are no "sweet-tooths" among the birds. American workers have found that xylose, a sugar which does not taste very sweet to Man, is particularly disliked by fowls, rejection increasing with concentration. They conclude that sweetness, as we recognize it, does not apply to the hen. Fowls have also been tested with a number of artificial flavours, and many were rejected at a strikingly low concentration. Some substances, such as colocynth pulp, which we would regard as bitter and unpleasant, were accepted, while others in the same category were rejected. The search for repellent substances, therefore, should not be governed by our own ideas of the sense of taste, and special caution must be used with chemicals which we would classify as bitter or sweet.

The electrophysiological experiments and preference tests taken together show that pigeons and fowls have well-developed gustatory equipment. Solutions of the active ingredients of several commercial repellents were also used in the preference tests, and the majority produced a marked reduction in intake by the pigeons, when compared with the water standard. The next step in the search for a suitable repellent was to use solutions to which the birds had shown an aversion, mixing one of them with their food. Here, new problems arose. It is no easy matter to deter a moderately hungry pigeon from its food, and the application of acid or alum solutions to the grain was unsuccessful in this respect. When offered a choice between such treated grain and untreated grain, they generally, however, ate rather more of the untreated sample. These substances were chosen because the pigeons had shown a marked dislike of them during the preference tests.

Experiments have shown that hens are primarily influenced by the shape of the grain and secondarily by its colour in their preference for certain cereals. The taste of the grain did not appear to alter their behavioural response. The addition of flavouring substances had little effect, particularly in comparison with the alteration of the tactile sensation achieved by coating the grain with a dry powder or with waterglass. The hen is said to produce relatively little saliva, and it has been suggested that this fact may explain why the bird is so much more sensitive to flavours added to the water rather than to the food. To be effective in stimulating the taste buds, substances must be in solution.

Two further points about the experiments are worth mentioning. The hen and the pigeon are domestic birds, and both species will feed on an essentially similar diet. It is therefore unwise to generalize from these results, and it would be interesting to continue the experiments using insectivorous or aquatic species.

Much of the spadework can be done in the laboratory, but the final phase of the investigation, and always the critical test, is to determine the effect of possible repellents in the field. The trials reported to date have been disappointing and it is apparent that, like Thursday's child, we still "have far to go".

American Newsletter

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from JOHN LEAR

Social implications of space research

NEW YORK

EXPLORATION of the space between planet Earth and other planets of the Sun "will very probably be the most costly of the various exploitations of technology and science that present societies are currently prepared to undertake during peacetime". That statement appears in the introduction to a report that has just been completed by the Brookings Institution for the National Aeronautics and Space Administration. Because the observation strikes me as an understatement of the truth—in which the words "very probably" could properly be substituted by the words "almost certainly"—this letter is the first of several I shall write about other things the Brookings study has to say.

To begin at the beginning, the American adventure beyond Earth's atmosphere has its legal sanction in the National Aeronautics and Space Act of 1958. Among other injunctions this law commands that "the aeronautical and space activities of the United States shall be conducted so as to contribute materially to . . . the establishment of long-range studies of the potential benefits to be gained from, the opportunities for, and the problems involved in the utilization of aeronautical and space activities for peaceful and scientific purposes". What the "peaceful and scientific purposes" might be, and how they should be achieved, were thus left to NASA to determine.

In November 1959 NASA passed this hot potato to Brookings by requesting that notoriously discreet and intellectually disinterested agency to "undertake . . . the design of a comprehensive and long-term program of research and study regarding the social, economic, political, legal and international implications of the use of space for peaceful and scientific purposes". Brookings in its turn handed the dilemma over to a new member of its research staff, psychologist Donald Michael, whom readers of the *New Scientist* may recall as the social scientist I collaborated with two years ago in a poll of popular opinion on the meaning of Man's then impending embarkation on the electrical sea of inter-planetary mystery.

Psychologist Michael is refreshingly candid in stating the first finding of his study: "A conclusive demonstration that some space activities provide superior means for benefiting mankind is still in the future." With a touch of something that seems to me to lie between wistfulness and hope, he adds: "Possibly a near future."

As opposed to this initial and in my mind significant uncertainty, a certainty is declared: "They [space activities] are already an established factor in our society that confronts mankind with special problems."

Since Brookings is a conservative institution and staffman Michael, though young, is no fool, the report is firm in defining its own footing:

"It must be clearly understood that this report does not attempt to predict what *will* happen to society as a result of space activities nor to anticipate all the implications of a given space activity. . . . But by posing questions regarding what *might* happen and specifying those contingent factors which *may* affect the likelihood of one implication being realized rather than another, we will be better prepared to take advantage of the implications of space activities than we would be without such inquiries."

Even in this realm of *might be*, Michael and the group of social scientists who worked with him do not risk speculating beyond the year 1980. Some scientists they consulted wanted to cut that short period in half. General agreement was found on a high degree of unlikeliness "that lunar colonies and manned flights to Mars will be more than newspaper headlines in terms of their implications for the man in the street during the next two decades". Consequently, only "symbolic effects of such events" are considered. On the other hand, "such space products as communication and weather satellites have been examined in detail" because, though "they may not actually result in full-scale operating systems with large implications for society within our chosen time period", there is "a very good chance of substantial implications being generated by them in the next two decades".

Three types of research are recommended:

1—Research directed toward developing better understanding of specific implications of particular activities. Example: the economic, legal, political and personnel requirements for a world-wide ground-based weather-data collecting and processing system to make weather satellites meaningful in the practical sense.

2—Research on methods for anticipating and evaluating impact of space activities.

3—Research on fundamentals of human behaviours and institutional processes. Example: the processes which decide how slowly or quickly different societies accept innovation.

The word "research" itself is stretched to encompass these three objectives fully. It includes "'think-pieces', sophisticated logical and/or mathematical evaluations and analyses, and empirical studies in the field". Hence it is more speculative than traditional. Where it will lead remains to be shown, but Michael and his group at Brookings think it holds considerable promise as a policy planning aid when reinforced with operations research, systems analysis and decision theory.

Tradition is thrown completely out the window when it comes to assigning particular experiments. Not only is the greatest weight thrown on social science—which only last month reached maturity in the eyes of the National Science Foundation—but the usual disciplinary lines within it (political science, sociology, economics, anthropology, law, etc.) are swept aside. Instead, the space planners look at *problem areas* "since the impact of innovation on society is no respecter of differences in academic disciplines".

The Brookings report proposes that the peaceful space research programme be bossed within NASA, by a triumvirate of social scientists who would have a direct pipeline to top NASA administration and memberships on divisional deliberate committees within NASA. These three men then would decide what research would be contracted for, and with whom. They would be assisted by two advisory boards: one to suggest projects and another to review progress periodically and cut off experiments that are dying on the vine.

The overriding philosophy says that "a program of research to clarify the implications for society of peaceful space activities cannot be accomplished by fits and starts".

In next week's letter, I shall report the Brookings report's speculations on the implications of Earthly communication by way of many moons.

This is Broadsheet No. 21 from the City of Steel

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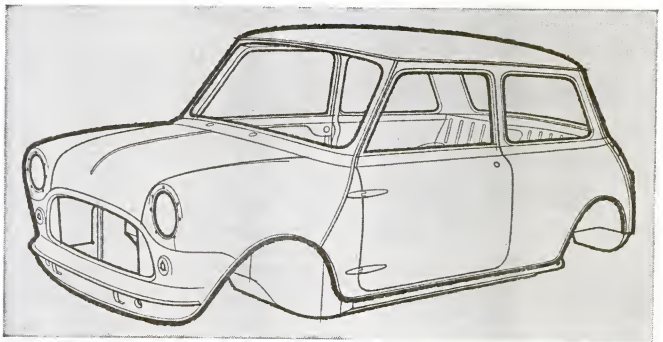


This is a British car body—typical of many which are built from sheet steel, and composed of many complex pressings. The wings are among the more difficult parts to press into their intricate shape. The new VLN steel is helping with problems of this kind.

Revolutionary VLN process cuts down nitrogen, gives greater flexibility

From this year on, the versatility of steel, the flexibility of steel, will be even greater. The reason: a new steel-making process developed at The Steel Company of Wales, Britain's City of Steel.

The name of the process is VLN; in full, Very Low Nitrogen. And the significance of VLN is fundamental.

The motor car industry, and all other industries which press sheet steel, require certain of their steel to have great *ductility:* that is, the ability to be pressed into intricate shapes without breaking.

In making steel for this purpose, a vital consideration is its nitrogen content; for the less nitrogen a steel contains, the longer it will remain ductile. Mild sheet steel made by the new VLN process has the lowest nitrogen content in the world.

UNIQUE PROCESS

The VLN process is unique. Already it has been proved not just in theory but in practice. As you read this, a VLN plant, consisting of three oxygen/steam blown 50-ton converters, is in full production at the City of Steel. So confident is the Company in the future for VLN that it is about to install a fourth converter.

Unless you are a manufacturer who uses sheet steel, you will hardly be conscious of VLN and certainly not of its practical advantages.

But this does not mean that VLN will not affect you; for without such developments, Britain's industries could not long succeed in the tough competition of world trade; and the success of our industries affects us all.

THE STEEL COMPANY OF WALES LIMITED

Profile

Professor Ritchie Calder

A demolitionist among the ivory towers

EDINBURGH UNIVERSITY's newest professor is no diffident academician. Ritchie Calder is a strongly-built, dynamic man of 54 with a strong voice, a quick wit and a versatile platform approach. He is equally at ease at an open-air political meeting or as a participant in a learned colloquium.

By his appointment to the Sir Montague Burton Chair of International Relations at Edinburgh, Calder—ex-crime reporter, science journalist, world traveller and lifelong socialist—becomes one of the very few professors who have themselves had no university training. But his has been a lifetime of uncommon achievements. He is, in fact, a unique figure. He has spent the past 30 years bridging intellectual gulfs, translating between the worlds of the uncommon and the common man, with salty phraseology and an outstanding gift for helping minds to meet. That scientists today are readier than they were 30 years ago to explain their work and aims to an ignorant world—or even to other scientists—is due in part to Ritchie Calder's indefatigable pioneering in innumerable articles and broadcasts and his many books. Not only has he helped to persuade millions of readers that "science makes sense", but he and his followers and colleagues in scientific journalism have enabled specialists to understand something of the public's need for instruction.

And yet he had no formal training in science. Peter Ritchie Calder left Forfar Academy at the age of 15 to become a cub-reporter on the *Dundee Courier*. Brains, persistence, energy and a strong physique he had. Science was to come later. When it came it was bound up inextricably with a warm sympathy for human needs. If someone gave Ritchie Calder a hundred million pounds to spend there is little doubt that he would use it rather to found a health service than to launch a space rocket. Feeding the multiplying millions, abolishing poverty, getting rid of disease, sharing knowledge and experience—these and their like have ever been his ideals, whether in Britain of the 1930s or the world of the 1960s.

These, too, are the basic principles he will have in mind in his new professorship. For Calder is, as J. B. Priestley said, a genuine citizen of the world. Apart from journalism, authorship and lecturing, much of his work since the war has been concerned with United Nations Specialized Agencies, several of which he regularly serves as a consultant. On their behalf he has crossed deserts and jungles, shared igloos with Eskimos and journeyed over the Arctic and the Sahara. His travels for the United Nations have taken him, indeed, over most of the habitable world as well as much that is not very habitable but which could become so if, as he passionately believes, scientists and statesmen would get together, pool their knowledge and apply it.

In Dundee Calder reported the police courts. At 17, he was sent by his paper to London. He worked for a short while in Glasgow, then moved to *The Daily News*. There are many in Fleet Street who recall him as a keen general reporter in the 1920s, writing of rifts in the Salvation Army, reporting fires and train smashes; hobnobbing with detectives in the pursuit of crime news. He has himself remarked that there is much in common between research and crime detection. Lord Rutherford was, says Calder, "very much a Scotland Yard type, seizing upon clues, examining their significance, deducing their possible explanation and then patiently reconstructing what might have happened".

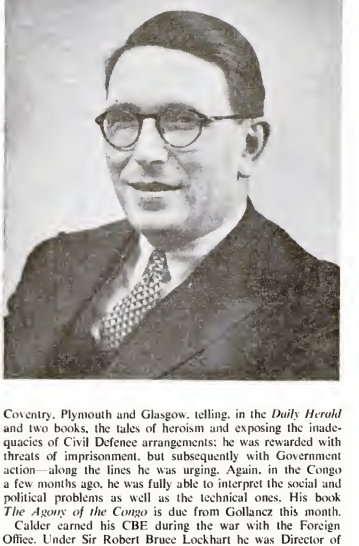
Calder used the same methods to learn about science. When Rutherford threw down a paper covered with cryptic signs and formulae, arguing that no non-scientist could understand it, the reporter was ready with his answer. He produced his own notebook. "If you will transcribe my shorthand I will translate yours", he said. He has been translating ever since.

This first hurdle surmounted, Calder went on to learn from many other scientists, haunting their laboratories, reading their books, zealously studying and remembering. He made them his friends, and not a few today are ready with encouragement and congratulation for the new professor whom they (like his new Principal, Sir Edward Appleton) first met in the 1930s with a notebook and a questing mind. Impact was slow in those days, for scientists distrusted journalists, but Calder's earnest preaching that science *must* make itself understood, coupled with his clearly remarkable talent for explaining the mysteries of research to laymen, won him steadily increasing cooperation and respect.

From atomic science Calder went on to investigate all the main developments in science: electronics, biochemistry, nutrition, and so on. Soon he was writing regularly on science in the *Daily Herald*, and producing his first and characteristically entitled book, *Birth of the Future*. As Sir Frederick Gowland Hopkins, then President of the Royal Society, wrote in its introduction, "We said to ourselves 'If this be a journalist, it is a journalist with a difference' ". Science had found a Boswell.

Throughout the years of crisis Calder has managed to follow the middle road between capitalism and Communism without compromising either his ideals or his position. He joined the Labour Party in 1924 in Dundee, learned to think on his feet and work in committee; in 1936, by now a practised speaker, he took part with Ellen Wilkinson in the Jarrow March. Since then, without parliamentary ambitions, he has given much of his time to Labour meetings up and down the country, and is a member of the Fabian Society executive. At present he is Vice-Chairman of the Campaign for Nuclear Disarmament and has trudged the road from Aldermaston.

He has never allowed his specialization in science writing to diminish his versatility as a journalist. (He is certainly the only professor who has fallen off the flying trapeze at Olympia.) During the Battle of Britain and the 1940-41 Blitz he went where Goering's bombers went, to the East End of London, to



Coventry, Plymouth and Glasgow, telling, in the *Daily Herald* and two books, the tales of heroism and exposing the inadequacies of Civil Defenee arrangements; he was rewarded with threats of imprisonment, but subsequently with Government action—along the lines he was urging. Again, in the Congo a few months ago, he was fully able to interpret the social and political problems as well as the technical ones. His book *The Agony of the Congo* is due from Gollancz this month.

Calder earned his CBE during the war with the Foreign Office. Under Sir Robert Bruce Lockhart he was Director of Plans of the Politieal Warfare Executive from 1941 to 1945, engaged with a brilliant team of experts and amateurs in spreading alarm and despondency in enemy territories, and hope among the resistance movements, from a secret headquarters "somewhere in England". Here he learned at first hand how to keep a group of temperamental men working in harmony. He became a war casualty. In 1944 his young family was bombed out, his offices were wrecked by a V1 and all the time he worked unsparingly at the complex politieal warfare problems of the invasion of Europe; until, that summer, his tireless brain gave out and he collapsed in the street with a haemorrhage. Only swift and brilliant treatment saved his life.

From his last wartime post as Speeial Adviser at Eisenhower's Supreme Headquarters in 1945, Calder returned to Fleet Street, this time as Science Editor of the *News Chronicle* and a member of the editorial board of the *New Statesman*. Soon after he joined the *News Chronicle* he was invited to Washington by Lord Boyd-Orr, then Director-General of the Food and Agrieulture Organization, as special adviser at the 1946 Famine Conference, and was a member of the United Kingdom delegation to Unesco's first General Conference at Paris in 1946 and its second in Mexico City the following year. It was at the invitation of Unesco, preparatory to the setting up of its Advisory Committee on Researeh in the Arid Zones, that he undertook his first big-seale mission, to the deserts of North Africa and the Middle East, involving a journey, often arduous and difficult, from the Western Sahara to the Salt Deserts of Persia. Out of this came a striking series of articles, broadcasts, and his book *Men Against the Desert*.

That journey, completed in 1949-50, led three years later to another on-the-spot survey, this time of the problems and needs of Thailand, Indonesia, Burma, India, Pakistan and Afghanistan, carried out as head of a special information mission to South-east Asia on behalf of the United Nations, the Technical Assistanee Board, UNICEF, FAO, WHO, Uneseo and the ILO. Another book followed: *Men Against the Jungle*.

The United Nations and the Specialized Agencies assigned him in 1955 to spend four and a half months in the Arctic at the invitation of the Canadian Government, to survey the possibilities of development of the "frozen north" as part of the habitable world and report on the soeial and techniea1 consequences such development would have. In 1960 Calder toured the Congo as United Nations and WHO consultant during the crisis period.

Between journeys Calder managed to find time to serve on the UN secretariat at the International Conferences on the Peaceful Uses of Atomic Energy (in 1955 and 1958) and a WHO study group on the Mental Health Aspeets of Atomic Energy: to work actively for the United Nations Association in Britain, the Workers' Eduеational Association, of which he is Viee-President, and the British Association for the Advancement of Science: to write another half-dozen books and to keep up a stream of articles and radio and television programmes.

His twentieth and most ambitious book, *The Inheritors*, due for publication this year, is an attempt to trace the development of Man's struggle to come to terms with his environment from prehistory to the present day, with excursions into the future, illustrated from personal travels and studies over 30 years and imbued with Calder's firm belief that global cooperation in the shrewd applieation of seientifie knowledge provides humanity's sole hope of survival.

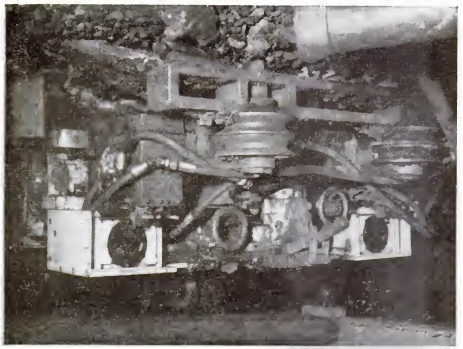
Knowledge must be shared. This is Calder's gospel and his reason for taking a leading part in a ten-day conference at the Weizmann Institute last summer, devoted to "Science in the Advaneement of the New States", out of which arose a firm proposal for the establishment of fellowships and scholarships for the training of Afriean and Asian students.

His close friend H. G. Wells inscribed in *New World Order*, "To Ritchie Calder, who will help bring it about, from H. G., who won't live to see it". Calder enjoys life in the developing new order, and preserves so youthful a demeanour that people are surprised to learn that he has five children and seven grandchildren. He brings to academic work the same enthusiasm he has given to all his other responsibilitijes. But his teaching is to be so arranged that for most of each year he will be able to continue his travels and his writing.

Ritchie Calder has been described as a "common law scientist who has lived with science so long that he is married to it by habit and repute". The union has been good for science as well as perpetually fascinating to Calder, for he has made an immense contribution to demolishing the ivory towers, and to giving contemporary science a sense of direction and social purpose.

Science in British Industry

Automatic coal mining with gamma rays



Rear view of the Midget Miner coal-cutting machine fitted with the new coal-sensing device. The dials show the thickness of the coal left on the floor of the seam after the passage of the cutting head.

THE MECHANIZATION of coal mining has almost doubled in the last three years and now accounts for 40 per cent of the tonnage won from British coalfields every year.

The next logical step is to develop remotely controlled cutting machines which do not need the personal supervision of a human operator. This conception, however, raises the difficult problem of keeping the machine within the coal seam, so that it follows the undulations of floor and ceiling, cutting close to the rock but never into it. The Mining Research Establishment at Isleworth, Middlesex, has made a considerable advance in this direction by producing an apparatus which senses the thickness of coal being left on the floor of the coal face as the cutting machine advances.

The principle on which the device is based is the difference in the back-scattering of gamma radiation from coal and rock. The gamma rays are emitted by a small radioactive source contained in the sensing device. The total back-scatter from both media, measured by a Geiger counter, can be related to the thickness of the coal, which can be measured with an accuracy of $\pm\frac{1}{2}$ in. up to a maximum thickness of 4 in. Greater thicknesses are indicated simply as being in excess of 4 in.

A Midget Miner machine at New Lount Colliery in the East Midlands has been fitted with the device—possibly the first installation of its kind in the world. It is capable of cutting 2 ft 3 in. of coal out of a seam 2 ft 7 in. thick. Two sensing devices are mounted in the skids which support the machine, as close to the cutting heads as possible. The skids are coupled to the Midget Miner by means of four hydraulic jacks which steer the machine in the vertical plane.

At present the device is not used as a remote-control system. The signals from the Geiger counters are displayed on dials graduated directly in inches of coal for the benefit of the operator. The device has greatly simplified the operator's work, and excursions into the roof and floor have been virtually eliminated, reducing the amount of free dirt in the mined coal.

The great promise of the sensing equipment, however, is that it opens the path to the complete automation of coal cutting. Work is now in progress at the Establishment on the design of a suitable servo system which will link the sensing unit to the hydraulically operated steering jacks, so eliminating manual control.

Automatic cop grading

A NEW machine developed by the Wool Industries Research Association, Leeds, automatically grades cops of yarn into one or other of six types by weight.

The machine is electronically operated and works against a predetermined standard weight. Cops are fed into the unit and an Avery "shadow weight" scale operates a selector mechanism which diverts the cop into the appropriate bin. To this automatic sorting is added a visual counter which shows at a glance the numbers of cops handled.

Any cop that is either excessively under or over weight is rejected by the mechanism; only cops falling within the agreed limits are passed, and this enables subsequent processing to be maintained at a consistently high level. With the new machine it is possible to grade up to 1,800 cops per hour, depending on the speed of the operator. No special skill is required to operate the machine; the cop is simply placed on the weighing pan, from which it is automatically discharged to its respective bin.

From initial descriptions of the machine it is evident that there should be no serious difficulty in feeding it from a hopper, lowering still further the individual handling. The WIRA cop grader is now being built commercially by Lancashire Dynamo Electronic Products Ltd., Rugeley, Staffs.

Sowing with SID

AN experimental machine called SID (spray-incorporating drill), designed to improve the reliability of soil-acting herbicides, has shown considerable promise in preliminary trials lasting two years.

Built at the National Institute of Agricultural Engineering at Silsoe, Bedfordshire, the machine sows seed in a weed-proofed bed of soil. Herbicide is mixed into the soil in 9-inch-wide bands by means of rotary cultivators, the soil is compacted to form a standard seed bed, and the seed is then sown at precisely pre-determined intervals.

Before this new technique was devised, very variable results were obtained with soil-acting herbicides. When they are incorporated into the soil prior to sowing, the method of mixing and all the environmental and soil factors at work during the interval between application and sowing greatly affect the efficiency of the herbicide. Similarly, when herbicide is applied soon after the crop is sown but before it emerges, the weather and the state of the

seed bed between sowing and spraying markedly influence the movement and stability of the herbicide in the soil and hence its concentration in the neighbourhood of the germinating weed and crop seeds. By eliminating the time factor, SID simultaneously cuts out these other variables.

The advisability of sowing seed immediately after rotary cultivation is somewhat debatable, for in theory lack of firmness and consequent loss of soil moisture might be expected to impair germination. So far, however, there has been no indication that this is likely to prove a serious problem.

Another promising result of the trials made with SID by the Weed Research Organization at Begbroke Hall Farm, Oxford, has been the unexpectedly low incidence of crop damage despite the close proximity of herbicide and plant roots over a long period.

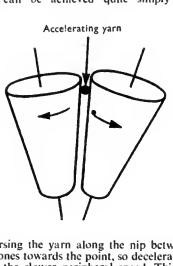
Although the machine was primarily designed as a further step towards the total mechanization of sugar-beet growing, the Begbroke trials, in which seven other crop plants have been safely treated with about a dozen herbicides, show clearly that the basic principles are relevant to the treatment of any row crop.

Eliminating the shuttle

A LARGE amount of weaving research today is directed towards eliminating the traditional flying shuttle, which has to be projected at high speed and stopped at the opposite side of the loom. Power consumption is considerable and out of all proportion to the amount of weft yarn inserted in the fabric with each "pick", or traverse of the shuttle. In Sweden and Czechoslovakia pneumatic looms have been developed to blow the weft yarn across the loom and thus eliminate the shuttle. The Czechs have also evolved a hydraulic system, using a jet of water instead of air, but this is suitable only for hydrophobic synthetic fibres.

Now a completely new system of weft insertion is being developed by Professor J. J. Vincent, Department of Textile Industries, Manchester College of Science and Technology. This is again a direct method of shuttleless weft insertion, but Professor Vincent describes it as being based on solid friction rather than on fluid friction, as used in pneumatic and hydraulic looms.

The weft yarn is taken between the nip of two cones rotating at high speed and is projected through the warp "shed"—the opening between the upper and lower warp yarn threads, which permits the insertion of the weft thread. In a demonstration, a coarse cotton yarn was projected six feet through a ring 1½ inches in diameter. The yarn is given an initial speed of 210 ft per second, but higher speeds could be achieved relatively easily. A slow-motion ciné film, taken at 5,000 frames per second, showed a tiny bunch of material at the tip of each yarn, caused, it is thought, by an initially lower acceleration than is attained by the following yarn, which causes the overtaken yarn to be "snarled". This can be a serious disadvantage as it could cause entanglement and so prevent even weft insertion. It also means that with each pick there is a tiny amount of waste yarn which in a large piece of cloth would be quite sizeable. To overcome this, it is felt that a progressively retarded delivery is probably the answer. This can be achieved quite simply by



traversing the yarn along the nip between the cones towards the point, so decelerating it by the slower peripheral speed. This, it is hoped, will disentangle the snarl and allow a perfect pick to be inserted.

Fine yarns could, in theory, be woven across widths up to say 60 inches—ample width for most fabrics. The system is ideal for coarse yarns and for paper or wire yarns. It is also highly probable that it will be suitable for weaving monofilament synthetics.

In a lecture recently, Professor Vincent said it was hoped to see the system on a loom able to weave at speeds up to about 500 picks per minute, which compares with the present maximum of about 200.

Some cloth has already been woven by this system and it appears to be very promising. Loom builders are interested in the technique, but it remains to be seen just how long it will be before a commercial loom is available. This will no doubt depend largely on the financing of the research programme and the amount of practical interest evinced by loom builders.

Electrostatic disturbances in needle gauges

ERRORS as large as a fortieth of an inch can occur when conventional needle gauges are used for determining the heights of a column of a non-conducting liquid. In a typical gauge, which is usually reckoned to be accurate to within plus or minus one thousandth of an inch, a needle point is gradually lowered by manipulation of a micrometer screw until it just touches the surface of the liquid, and the instant of contact is detected either visually or with the aid of an electric circuit.

Recent investigations carried out by A. T. J. Hayward at the National Engineering Laboratory, Glasgow, have shown that when the point of the needle is about 0.5 inches above the surface of oil or any other non-conducting liquid there is a rhythmic disturbance of the surface immediately below the point of the needle and the surface tends to jump upwards towards the needle with a frequency of one cycle per second. This is due to the electrostatic charge which is unintentionally imparted to the vessel while it is being cleaned immediately prior to use. The electric charge can be dissipated and accuracy restored simply by earthing the needle. The phenomenon does not occur with de-ionized water, which has a lower electrical resistivity than oil.

Ultra-pure water

ULTRA-PURE water, which is used to help remove trace impurities during the washing or rinsing of semiconductors and transistors, can now be produced on an industrial scale using an ion-exchange process recently developed by Elga Products Ltd., of Buckinghamshire. Ordinary tap water is first passed through a strongly acidic exchange resin which replaces all the positively charged metallic ions with positively charged hydrogen ions. The effluent then passes through a second and equally strongly basic anionic column, in which the chloride, sulphate and carbonate ions are replaced by hydroxyl ions. Hence, all the mineral salts are replaced by hydrogen ions and hydroxyl ions which combine together to form more water.

During the second stage, this water, which is about as pure as ordinary distilled water, is pumped through polyvinyl chloride, stainless steel or polythene pipes to the site where the "intrinsic" or ultra-pure water is actually required. There it is finally passed through a small mixed-ion exchange bed which may be thought of as a multi-bed deionization plant consisting of countless cationic and anionic columns alternately connected in series. Reports state that the intrinsic water so produced has an electrical conductivity of about 16 megohms per cubic centimetre.

Granulated iron

GRANULES of iron, obtained by pouring molten metal from the blast furnace directly into water, are more convenient to handle and to store than the short rectangular slabs of iron commonly used. A new plant, now in production at the works of Esperance-Longdoz, near Liège, is the fourth to come into operation since the technique was first developed just over three years ago by the British company of Stewarts and Lloyds Ltd. The process is reported to be simple and safe in operation, and to be capable of producing up to four tons of granules a minute.

The secret of success lies in the correct adjustment of the flow rates of both water and molten iron so that the temperature of the former never rises above 90° C, ensuring that the right sized granules are produced. The capital cost is relatively low.

Science in Overseas Industry

UNITED STATES

Weather charts by electronic computer

An electronic unit which automatically draws a complete weather chart of the northern hemisphere in three minutes has recently begun service at the US Weather Bureau. Numerical information from 500 weather stations, gathered twice daily, is fed into the computer by magnetic tape. It is converted into analogue form and used to guide a mechanical hand over a 30 × 30 inch map to draw isobars, or lines of equal barometric pressure, as shown in the illustration. When drawn by hand each map took 20 minutes to produce; the "weather plotter" now working at the National Meteorological Centre does the job in three minutes and, according to the Director, Dr. G. P. Cressman, does it more accurately. In the course of 24 hours, 64 weather maps are drawn for different altitudes from sea level to 40,000 ft. Some are used by the aviation authorities to determine the best flying routes and heights for jet aircraft. As each map is produced it is transmitted facsimile to 26 US weather stations and 600 military bases and commercial undertakings. Dr. Cressman said that the device will assist the Weather Bureau's efforts to automate weather data processing, weather analysis and forecasting. Other weather plotters will shortly be installed at Air Force and missile bases. The unit is produced by Electronic Associates Ltd. It is described as a development of the company's data-plotting equipment designed to help in work such as highway planning.

Anti-shrink wool

BY depositing a very thin film of nylon directly on to wool fibres, chemists at the United States Department of Agriculture have found a new way of making woollen fabrics virtually unshrinkable, even after repeated laundering. The wool is simply passed successively through solutions of hexamethylene diamine and sebacoyl chloride. The two chemicals polymerize at once on the fibres at room temperature, forming a coating so thin that it increases the fabric weight by less than 1 per cent. After twenty trial washings, treated fabric showed a shrinkage of less than 2 per cent.

Chemical Engineering News reports that the process has been operated successfully in commercial-scale equipment, after its initial development at the laboratories of the Agricultural Research Service in Albany, California.

Liquid-metal fuel cell

AN hour's continuous run of a thermally-regenerative liquid-metal fuel cell under laboratory conditions is reported from the United States. It appears to depend, in principle, on heating two metals until they separate. Their recombination on cooling creates an electric current. This type of cell, in developed form, is regarded as likely to be suitable for supplying power to instruments in rockets.

Fuel cells are devices for converting chemical energy directly into electrical energy. An example using hydrogen and oxygen was demonstrated in England in 1959 (*New Scientist*, 27 August, 1959), and was made to do useful work.

The thermally-regenerative cell is claimed to be the first of its kind. It has been developed by Dr. Bernard Agruss, of the Allison division of General Motors. A new kind of electrolyte is said to be likely to allow this cell to be only one-tenth the size of other fuel cells giving the same electrical output.

12,000 m.p.h. pellets

WITH the object of improving the design of nose cones of ballistic missiles or other objects which have to re-enter the Earth's atmosphere, a piece of apparatus has been developed at Boston to facilitate detailed study of the stream of heated gas left in the wake of a fast-moving object in the thin upper air. It consists of a device for accelerating a small nylon pellet up to a speed of 12,000 m.p.h. in a chamber 20 ft long.

The energy is obtained by the sudden heating of 1 cu. in. of hydrogen contained in a steel cell, through which an electrical arc is struck. In less than one-thousandth of a second, the temperature of the hydrogen is raised to some 30,000° C and its pressure to about 70 tons psi. The hydrogen thereupon breaks through a copper disc and drives the pellet along the test chamber where changes in the density of its wake can be noted.

The air in the chamber can be varied in pressure to represent any height above the Earth's surface. The "gun" was developed at the AVCO Corporation's laboratory.

Domestic dry cleaner

THE development of a simple conversion kit for turning almost any brand of standard automatic washing machine into a dry-cleaning unit is expected to herald the expansion of self-service dry cleaning. Hitherto, the filtering of the solvent has been a major problem.

Camerland Colorado Inc., of Denver, Colorado, have now patented a simple filtration system, based on the use of diamaceous earth and activated charcoal, capable of keeping a batch of solvent usable for 200 cleaning cycles without the use of additives. The cleaning and filtration cycles are controlled electronically.

The change-over from water washing to solvent operation also involves boosting the power of the machine's electric motor from the usual ½ h.p. to ¾ h.p. to cope with the greater weight of solvent, and replacing rubber parts with plastic and metal to prevent corrosion.

CZECHOSLOVAKIA

Straightening buckled gears

COMPONENTS such as large gears which become distorted during heat-treatment or subsequent machining may be successfully straightened within a few minutes and without cracking or chipping the material. Straightening is effected by applying mechanical forces to a selected portion of the workpiece while it is being simultaneously heated with specially designed high-frequency inductors.

The localized heating effectively prevents stresses from building up and so avoids many of the drawbacks commonly associated with flame heating. After treatment the component may be quenched in oil or air and, in general, the metallurgical structure is unaltered. This technique (recently described in *Strojirenska Vyroba*) offers considerable advantages over the conventional mechanical straightening methods which, carried out at room temperature, may take several hours to complete.

Air bag used in vibration meter

A RELATIVE vibration meter developed by the Scientific Research Institute for Heat Engineering, Prague, uses an air-filled rubber container instead of springs to apply a constant force to the probe and hold it in contact with the vibrating object. Vibrations are transmitted from the probe, via an anvil, to a cylindrical rod carrying a pick-up coil, which is free to move axially in the air-gap of a permanent magnet. As the rod vibrates, a voltage proportional to the velocity of vibration is induced in the coil.

The upper end of the rod presses against the underside of the flexible air container, which applies a constant force to the rod and probe over a wider range of operation than is possible with springs. The pressure of air in the container can be readily adjusted by means of a valve. The volume of the container remains constant despite the distortion produced by the movement of the vibrating rod.

The vibrating components of the pick-up weigh only three-quarters of an ounce, and it is claimed that this enables vibrations to be satisfactorily measured at maximum accelerations of 50 g. Relatively small amplitudes of vibration at low frequencies can also be readily determined. The velocity, acceleration and displacement components of vibration can all be measured when the instrument is used in conjunction with a milli-voltmeter.

GERMANY

Secure cargoes

EVER since the Phoenicians first started trading in ships a shifting cargo has been the symbol of the sailor's nightmare. Charles Sartori, a German inventor, suggests that sailors employed on grain cargo ships may henceforth sleep in peace. He proposes that a tough inflatable balloon, or series of balloons, should be introduced between the top of the cargo and the underside of the deck. The balloons would be inflated with compressed air supplied by the engine room, and arrangements could be made for the balloons to be further inflated as the cargo settles. If successful this looks as though it might well offer considerable economic advantages over the present somewhat inflexible, cumbersome and time-consuming method of securing the cargo with tarpaulins, chains and ropes. In all probability, turn-round time could be reduced.

Infra-red sorting of salt crystals

PURE salt crystals are transparent to infra-red rays, while impurities absorb them and so become warm. This fact has been used in an elegant manner in a new salt-cleaning arrangement.

Salt crystals are exposed to intense infra-red light for about a minute and then slide on to a belt covered with low molecular styrol resin, which gets sticky at a certain temperature. The pure crystals, being cold, fall off at the end of the belt; the impure ones, being hot, stick to it and are carried back at the bottom to a special reception box where they can easily be removed, having by then cooled down.

USSR

Improved heat-resistant glass

SILICA glass (composed of several metallic oxides) which has been heated to a temperature of about 660 C and then sprayed with a 10 per cent solution of an organo-silican polymer, polyethylsiloxane, has considerably improved resistance to heat. Investigations carried out at the Mendeleyev Institute of Chemical Technology, Moscow, indicate that the improvements result from three factors—the cementing over of micro-cracks on the surface of the glass, the increased concentration of silicon dioxide in the surface layer formed by the breakdown of the organosilican compound and the increased hardness of the glass brought about by the cool spray. In addition to its improved heat resistance, it is claimed that material treated in this way is mechanically strong, uniformly hardened and free from optical distortions.

The unknown Indian Ocean: an international investigation

Remarkably little is known scientifically about this vast Ocean. It is to be the subject of an oceanographic investigation which will provide invaluable information—concerning navigation, fisheries, meteorology, coastal engineering—to nations living around it

by Dr G. F. Humphrey

President, Special Committee on Oceanic Research, International Council of Scientific Unions

ABOUT 4,000 years ago, trading posts were established in the north-west corner of the Indian Ocean, and since then Man has made increasing use of the resources of that Ocean and of the bordering countries. Nevertheless the Indian Ocean is today, oceanographically, almost a *terra incognita*. More than a dozen countries are now planning the most extensive co-operative oceanographical investigation ever attempted anywhere in the world, and it is the Indian Ocean which is the centre of attention.

The investigation was first suggested by the Special Committee on Oceanic Research (SCOR) of the International Council of Scientific Unions. In 1957 the Council decided that marine sciences depended greatly on joint effort, and that existing arrangements were inadequate for encouraging and coordinating such effort. At its first meeting (August, 1957, in the United States) SCOR decided that it should plan an international investigation on one of the least-known and yet one of the most scientifically important areas. The Indian Ocean was chosen not only because it is poorly known scientifically, but also because it presents a variety of interesting and important problems. Some of these problems arise because the Indian Ocean has a seasonal reversal of winds (NE and SW monsoons) and is more or less closed on three sides with much land-drainage from the north. As a consequence, during the investigations much effort will be devoted to the peculiarities of water movements arising from the sharp reversals in wind direction. The biological consequences of these movements will also be studied. Again, the unique conditions in the Indian Ocean provide an opportunity for the critical study of the exchange of energy between the sea and the air. Such exchanges have important effects in determining weather patterns throughout the world.

The programme is being organized by SCOR through national committees which have so far been set up in 18 countries. To assist the organizing of the programmes, the US National Academy of Sciences has provided a coordinator whose main task is to stimulate early planning of cruises. With our present information it seems the cruises will fall into five categories:

1. Reconnaissance cruises by USSR, USA and Australia, 1959-62.

2. Close Japanese-Australian cooperation in the eastern half from 8° N to 45° S during two seasons in 1962-63.

3. Cooperation by France, Britain, USA, Zanzibar, USSR and possibly Germany in the Arabian Sea and southwards, mainly in 1963.

4. Work by three South African ships and a French ship along the east coast of Africa and in the region of the Agulhas current during 1962-63.

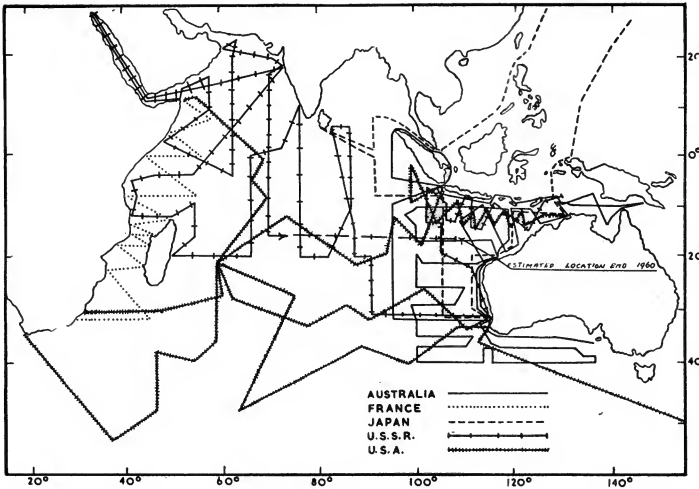
5. Work by Indian and Pakistani ships in their coastal waters in 1962-63.

Some of these ships will be well-equipped oceanographic vessels; others will be fishing or hydrographic vessels with special equipment aboard solely for the investigations. The cruises already completed or in progress are shown in Figure 1.

SCOR hopes that in addition to the scientific work being carried out there will be a great emphasis on training and that the newly-developing countries of the Indian Ocean region and of the Indo-Pacific and south-east Asian areas will seize the opportunity to nominate young scientists to take part in the sea-going and laboratory work. Already several countries have offered training places and UNESCO has expressed willingness to cooperate. In fact, training and the help which UNESCO could give have assumed such an important place that SCOR has asked UNESCO to act as a co-sponsor of the investigations.

There will be no master plan in the sense of a grid of stations to be followed, but the integrating principle will be that the scientists will agree on major problems which will orient the field work. The national committees will be kept informed of the discussions at the meetings of SCOR and of its working groups, and these committees will be in touch with the marine laboratories in the various countries. It is these institutes which will decide the cruise programmes. Thus these programmes depend greatly on the interests and facilities of the laboratories. The unique opportunity to collaborate on an international scale, and to concentrate several disciplines on a variety of important problems, have meant that laboratories throughout the world are, to some extent, setting aside their ordinary programmes. It is thought that such temporary dislocation of local investigations will be more than offset by the value of the new information which can result only from collaborative effort. As an example of the difference in approach of various laboratories, Table I shows some details for cruises recently started by Australia, Japan and USA.

Of the three countries mentioned in the table, Australia is the only one which borders on the Indian Ocean. Because of this, Australia does not have to allow for "dead" travel time to reach the area. The cruises by countries such as Britain, USSR and USA include several weeks simply on passage, and although this time is used to make oceanographical studies



Cruises already completed or in progress.

in the regions through which the ships pass, the consequent lengthening of the cruises raises problems of cost and of relieving staff at reasonable intervals.

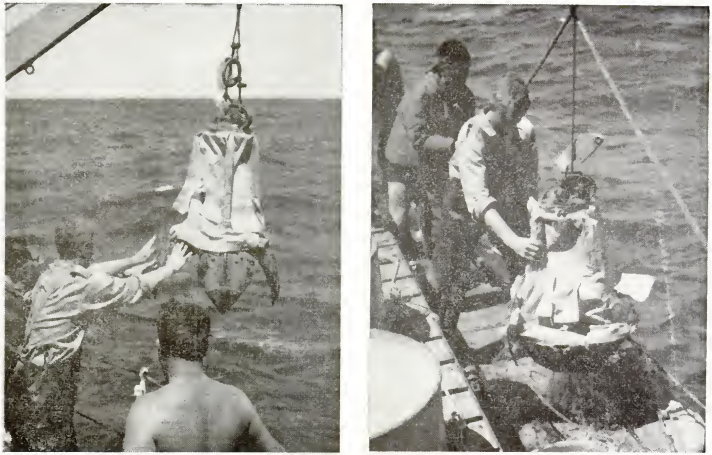
The proximity to the area also influences the type of work which is being done. For example, Australia is in a position to make regular cruises to the south-east part of the Ocean and has already completed five. The first aims were to find out for each of the seasons what types of plankton were present, what bodies of water were circulating and what was the productive capacity of the area. To do this, lines for stations were chosen and water samples collected from the surface to the bottom. Graphs of the temperature and density of the water allowed conclusions to be made about the patterns of circulation. At the same stations, nets were towed through the top 500 metres to collect the animal plankton; water samples were also collected in the top 150 metres so that the plant plankton could be centrifuged out and thus collected. The productive capacity of the water was measured by adding some radioactive sodium bicarbonate and determining how much was changed into or-

TABLE 1.

Types of cruises.

Country	Australia	Japan	USA
Ship	HMAS *Diamantina*	*Umitaka Maru*	*Argo*
Laboratory	CSIRO Division of Fisheries and Oceanography	Tokyo University of Fisheries	Scripps Institution of Oceanography
Route	Perth—Singapore—Djakarta—Pt. Moresby—Darwin—Perth	Tokyo—Darwin—Perth—Colombo—Singapore—Tokyo	Pt Moresby—Darwin—Djakarta—Cocos I.—Mauritius — Perth—Wellington — Tahiti—San Diego
Duration	3 months	4 months	6 months
Main investigations	Plankton collections Depth-sounding Upwelling off NW Australia Effect of SE Asian waters on Indian Ocean Water mass distribution	Plankton collections Depth-sounding Trawling Water mass distribution	Plankton collections Depth-sounding Seismic studies Bottom sampling and photography Magnetic determinations Trace elements

The unknown Indian Ocean: an international investigation *continued*



A grab going down to sample the sea floor and (right) being emptied of animals and bottom sediment it collected.

ganic compounds by the photosynthesizing action of the plant plankton.

The Japanese scientists on their cruise were interested in relating the oceanographic conditions to the occurrence of fish. Therefore animal plankton were collected because these are used by the fish for food and also the eggs and larvae of fish are sometimes caught along with the plankton. These plankton collections were made, together with determinations of the temperature and density of the water, at the same time as fishing operations were carried out.

The aims of the USA cruise were quite different from those of either the Australian or Japanese. This cruise was the first of the series to be made by the Scripps Institution and was a reconnaissance one which also tried to solve a few significant problems. The reconnaissance part was a loop nearly right across the Indian Ocean, with zig-zag runs from Djakarta to Mauritius, via Cocos Island, and from Mauritius east to Perth, via Amsterdam and St. Paul Islands. General oceanographic work was carried out, including water-sampling to the bottom, mid-water trawls, bottom dredges for biological material and mineral deposits and large samples of water for radiocarbon dating. The special problems were in the field of submarine geophysics and included plotting the structure of the Java trench and making seismic, heat-flow, magnetic and gravity measurements in the area. Similar work was done over the Indian Ocean Median Rise to compare its structure with the East Pacific Rise.

Although these three cruise programmes differ, they have some elements in common. For example, all will take depth measurements and all will analyse water samples. In general, the ships and laboratories use similar but slightly different methods, and if atlases and charts are to be prepared from the composite results, it must be shown that the methods give the same values or values which can be corrected to a common level. To determine the value of such correction factors, it is necessary to bring the working scientists and their apparatus together on to a ship or group of ships and to carry out intercalibration tests. Arrangements for this type of field work are already in hand and it is proposed that the first group of methods to be examined will be those concerned with the estimation of nutrient salts (phosphate and nitrate) in sea-water.

What will come from all these investigations? The cooperation will show that scientists and nations can join together in an exploration of a vast area of our globe, without thought of immediate national benefit. The coordinated information obtained will allow a solution of fundamental problems such as those concerning sea/air interaction. The surveys of water temperature, plankton distribution and water fertility will document the background against which the fisheries resources of the region will be assessed. The increase in the number of oceanographers in the area as a result of the training programmes will enable the Indian Ocean countries, especially those with a newly-developed interest in the value of marine sciences, to conduct their own research programmes and thus to solve their local problems, whether they be in navigation, fisheries, coastal engineering or meteorology.

In fact, these detailed investigations will provide the exact information necessary for the proper utilization of the great potential of the Indian Ocean as a source of food, raw material and energy, as a controlling factor in climate and as a means of communication between the neighbouring densely-populated countries.

MATERIALS FOR THE FUTURE—7

What can we do with whiskers?

Filaments of almost perfect crystals ("whiskers"), tightly bonded in a manner resembling fibre glass, will yield materials stronger than steel and a fifth of its weight. Lines of research designed to exploit their phenomenal strength are described here

by Dr George A. Hoffman

The RAND Corporation
Santa Monica, California

Typical appearance of "whiskers".

THE phenomenal tensile strengths of the thin crystalline filaments called whiskers lead us naturally to speculate on their possible use as some kind of structural material. Almost any crystalline substance can assume the whisker form under suitable conditions—metals, oxides, carbon, common salt and most other chemical compounds—and these whiskers have an important property in common; they are hundreds of times stronger than the bulk crystals (Figure 1).

Theoretically the strength of a solid depends on the attractive forces between its atoms, but in practice it is a very small fraction of these forces. The weakness is ascribed to the presence in the crystal lattice of a large number of defects, which allow planes of atoms to slip over each other. A whisker, however, has such a small cross-sectional area that there is hardly any room in which certain types of defects can exist, and consequently its lattice is quite regular and its strength begins to approach the theoretical limits of atomic cohesion.

The essential fact about whiskers, therefore, is that the thinner they are the stronger they are. Below a diameter of a hundredth of a millimetre their strength increases rapidly, and at a thousandth of a millimetre (one micron) it rises towards the theoretical limit.

Any attempt to weld whiskers together would simply produce large, non-filamentary crystals of normal properties, so the only way in which filaments could be made into a usable material would be to form them into a bonded composite somewhat like fibre-glass impregnated plastics. This process leads to some loss of available strength, as is evident from fibre-glass plastic itself, which shows only a third to a half of the available strength of the virgin glass fibre. But since whiskers are several times stronger than our present strongest metals, the resulting composite will still be of unprecedented strength.

It is envisaged that the closely packed whiskers would constitute as much as 80 per cent of the material and the bonding matrix the remaining 20 per cent. The whiskers should be aligned in layers, the layers forming a net or mesh at any desired angle among the aligned whiskers. These considerations invited us to closer study of the choice of whiskers and binders, the likely properties of the resulting material and the research necessary to mass produce such materials, once we established the economic feasibility of this concept.

Selected whiskers of equal diameter and different materials are not equally strong, of course, but neither are they of equal weight, and the substance chosen should be that which exhibits the highest ratio of strength to density. An index of whisker strength is Young's modulus—the elastic stress divided by the strain it produces. There is a limit stress beyond which a metallic whisker will not recover from the strain and will be permanently stretched; this occurs in some whiskers at strains as

high as 3 to 6 per cent, close to the theoretical limit. This means that the highest stress which the best whiskers can stand is some definite percentage of their Young's modulus, and this percentage has been observed to be fairly consistent for whiskers of many substances. Therefore it can be said that the highest strength of a whisker depends mostly on its modulus. And so the whiskers which are most likely to be useful are those with the highest ratio of modulus to density, made from such materials as carbon, boron carbide, beryllium, boron, silicon carbide, alumina and others. Micron-size carbon whiskers tested by R. Bacon, of the Union Carbide Corporation, withstood 2,000 kg/mm², compared with alloy steel's ultimate tensile stress of 100 to 200 kg/mm².

Another attractive feature is the behaviour of whiskers at elevated temperatures. Whiskers of all substances show less deterioration of strength with increasing temperature than the corresponding bulk material, until almost the softening temperature is reached, when they also suddenly weaken. Because the softening temperature can be related to the melting point of the material, we can predict from the melting point alone the temperature at which the whisker strength can be expected to fall drastically.

Thus, using only data on density, modulus, melting point and some simple assumption concerning modulus decrease with temperature, we can calculate the relative weights of whiskers of equal strength made of various materials over a range of temperature. The weights, relative to carbon at room temperature, of the six best materials are shown in Figure 2. Most whiskers should show a slow rise, with increasing temperature, followed at the softening point by a sharp increase in the weight required to maintain the same strength. It seems that carbon is unrivalled as a whisker material for both lightness and high-temperature properties.

Not all whiskers have the perfection of the carefully selected ones used in laboratory experiments. Some possess imperfections which make them weak in the region of the defect. They may be likened to chains in which some link is very weak. If a bundle of such chains is tightly bound together the composite strength reflects some average strength of the constituents, not of the weakest links, since the weak spots are by-passed by adjacent chains.

The choice of binder for whisker materials is dictated by its function in transmitting moderate shear stresses between adjacent fibres and across weaknesses in a given fibre. The binder must have a modicum of strength, and considerable ductility; moreover, its Young's modulus must be considerably lower than that of the whiskers, to ensure that the whiskers take most of the load when the material is uniformly strained. The binder should also wet and grip the filament, not affect it chemically, and preferably match its coefficient of thermal expansion. Plastics such as phenolics, silicones and polyesters, which are used with fibre-glass composites, may well be suitable for whisker binding. They fulfil all the above conditions except for their thermal expansion, and this mismatch might introduce residual stresses in a carbon-whisker composite after any thermal cycle. On this and other accounts it may be necessary to use other binders than plastics—possibly metals, which have more desirable combinations of properties: the question is being settled now by experiments. The plastic resins could be used up to 300° C, and developments of boron polymers may extend the temperature up to 500 to 600° C. With metal binders it is possible to envisage a suitable alloy which would meet most of the necessary requirements, even the matching of thermal expansion, and still be useful up to perhaps 1,000° C, though it may be necessary to coat the whiskers with a protective barrier material before impregnating the mass with the binder.

If carbon whiskers could be mass-produced with strengths about half that of the specially selected whiskers, and if we allow a 40 per cent weight penalty for the binders and coatings, the resulting whisker material would have the properties shown in Table 1, which gives comparative figures for a

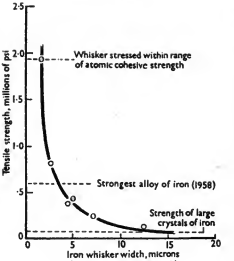


FIGURE 1. *The strength of pure iron whiskers as a function of their width.*

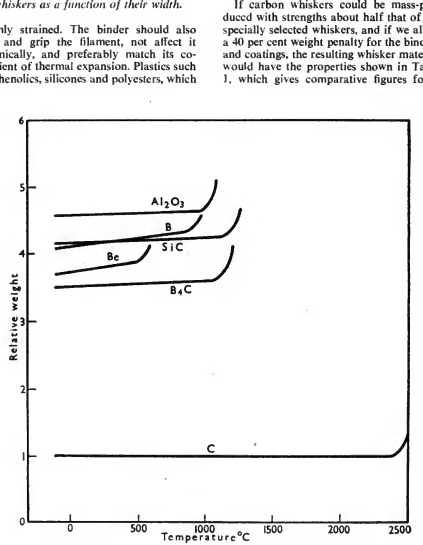


FIGURE 2. *Relative weight of equal-strength whiskers.*

What can we do with whiskers? *continued*

hypothetical whisker material, fibre-glass and a steel alloy. Also included are the relative weights of spherical pressure vessels of equal strength made from the three materials. The superiority of whisker material is quite clear.

Whisker composites are highly orthotropic—that is to say, their physical and thermal properties are highly directional. Many useful vessel shapes can be derived for such orthotropic materials, shapes that are uniformly stressed and therefore highly efficient: the most popular form at present is still the cylinder (Figure 3a) though the ovaloid (Figure 3b) and toroid would be also efficient for the many pressure vessels in space vehicles. Advantage can also be taken of the composites for such more mundane applications as cables, instrument components, gyrocompass parts, and tubing.

Whiskers may be produced in many ways, such as extrusion from soft metals under high stress, electrolytic deposition from a molten salt, condensation from a vapour, reduction of salts by the passage of hydrogen or the presence of a reducing agent, and precipitation from solution. In addition, vitreous filaments of micron diameters can be drawn from the liquid state of glasses, silica and some silicates, and although they are not as strong as whiskers they should not be overlooked. All these methods could conceivably be used for mass production. If the growth of crystals could be made orderly it would greatly facilitate their collection. This control of alignment, thinness and length may be achieved by proper saturation, temperature adjustment and the use of magnetic or electrostatic fields. The final harvesting would be effected by vibration or mechanical scraping.

From this point onwards the production of whisker composites would resemble the known techniques of fibre-glass manufacture. The spinning of the fine whiskers into strands and the weaving of the strands into sheets would be analogous to spinning and weaving in the textile industry. The woven product would be brought into its final form by impregnation with the coating

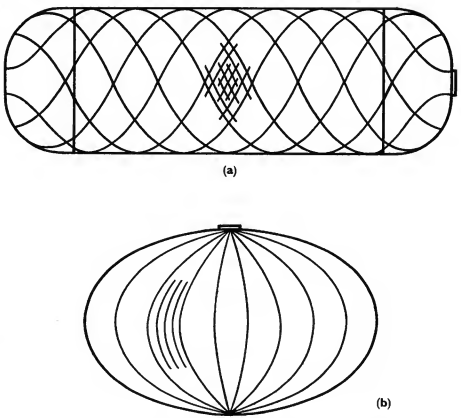


FIGURE 3. *Among the potentially useful shapes of pressure vessels made of whisker composites are* (a) *the cylinder with ovaloid ends using a mesh of strands and* (b) *the ovaloid with aligned strands. The lines indicate how the whiskers lie.*

chemical and with the binder, pressing, and curing.

Any estimate of the cost of whisker material is bound to be in the nature of a guess at this time, but it is sure that it will be expensive, as high as ten or twenty times the cost of other space vehicle materials. But 1 lb of whisker material can replace 5 or 10 lb of conventional materials, and the value or "worth-in-use" of this substantial weight-saving is extremely high, of the order of the whisker manufacturing costs. That is, the worth of saving 1 lb of vehicle weight (in £ per lb), being in the order of the production cost of the materials (also in £ per lb), permits an educated guess as to the economic advantages of a material that in turn permits a 5 to 10 weight reduction factor: the economics of the matter point thus to a 5- to 10-fold advantage.

It may be concluded that whisker materials possess just as attractive economic features as their technological advantages of allowing a weight reduction to a fifth or a tenth of present conventional materials. The production of whiskers in sufficient quantity and quality poses some formidable questions, though the manufacturing processes thereafter would be similar to those already in use elsewhere; thus the topics for research are copious. We must remember that it took forty years to advance from the observation of the strength of glass fibres to their utilization, and we may expect perhaps a generation to elapse before the effective exploitation of whiskers is achieved. The potential advantages are so great, however, that research on the subject is not being postponed, and many experiments are being carried out to exploit the phenomenal strength of whiskers.

TABLE 1

The hypothetical properties of whisker material compared with fibre-glass and steel. Also included are the weights, relative to steel, of spherical vessels of equal strength made from the three materials.

Material	*Density* g/cm^3	*Assumed Tensile Strength* (kg/mm^2)	*Modulus of Elasticity* (kg/mm^2)	*Relative Vessel Weight*
Whisker composite	1.7	600	60,000	0.10
Best-fibred-glass plastic (1960)	2.2	100	4,500	0.78
Steel alloy (1960)	8.5	200	20,000	1

It seems to me

by Geminus

POLITICIANS are notoriously indifferent to (and incompetent with) quantitative measurements, so that it is no wonder that the concept of "eudomony" which Sir Charles Goodeve dangled before a conference on operational research last autumn has fallen on stony ground. However, I am sure that with a little care most of them would be able to appreciate that this at least is one way in which it might be possible to give flesh and blood to that old political saw—"the greatest good for the greatest number".

To be fair to Sir Charles, I should point out that his main purpose was to prove by demonstration that there was no natural law which decreed that politics should remain a purely irrational activity. "Eudomony" was meant to be a quantity representing the attractiveness of life for a specified population in a particular social environment. Just as the temperature of a body (not politic but physical) can be regarded as a measure of the tendency there will be for heat to be transferred from this to some other body, so eudomony would be linked with the tendency of people to move from one society to another. And since a direct measurement of eudomony would be difficult, Sir Charles suggested that this could be done by measuring the migratory tendencies of human populations.

The implications of this doctrine are, of course, fascinating. For instance, once techniques had been worked out for measuring the country's eudomony on a day-to-day basis (perhaps there would be a daily record of the eudomony in the national newspapers) politicians would be exposed to a much more potent source of restraining criticism than any they experience at the moment. The introduction of unpopular Parliamentary Bills would be followed by a slump in eudomony before these could be debated. Sixpence off income tax, and up would soar this telling index of national morale.

The most serious practical difficulty, it seems to me, would be the need to make seasonal corrections to the index. After all, it would be misleading if there were to be slumps in the eudomonic index simply because it had been raining continuously for eleven weeks, or great upwellings of public feeling because it had been fine for Princess Margaret's wedding (the only fine day of 1960, as is well known). From a broader point of view it is worth remarking that the "maximization of eudomony" would seem a more sophisticated version of the old socialist doctrine, and that in any case it would be an excellent thing if politicians were to be perpetually reminded that their real job is to make the country one from which people do not generally wish to flee.

★

EVERYBODY is, of course, delighted that Professor Lovell is to be knighted, though his friends are properly sympathetic at the decision of some British newspapers that he should be entitled "Sir Space"—an epithet which some of them also used to mark the knighthood of Sir Harrie Massey a little while ago. It is particularly pleasing that Professor Lovell's name should have appeared on the Prime Minister's list in the New Year Honours, for this would outwardly serve to demonstrate that the Government as a whole is grateful for the initiative which Professor Lovell has shown in the creation of the Jodrell Bank telescope and the complex of research activity which goes with it.

Those with long memories, however, will know that nothing is further from the truth. Eagerly the Treasury has accepted the advice of the Public Accounts Committee that Manchester University should be left to its own devices in raising the outstanding debt on the telescope, and in the process has shivered the spines of all universities in which imaginative ideas are part of the stock-in-trade.

I know that Manchester University has proudly reconciled itself to this situation, and with all the rectitude of a canny north-countryman has set about paying its debts. "No one shall ever say that we couldn't pay in brass," the honest burghers of the town are probably muttering to themselves. Heroism of this masochistic kind is not, however, free from danger, and I myself am somewhat alarmed about the steps which might be taken in Manchester and other universities to implement the natural feeling "It shan't happen again!" The Treasury's miserliness about the Jodrell Bank telescope could easily complicate the launching of other similar research projects.

★

THE following excerpt from real life is offered to General Charles de Gaulle, President of France, to mark his recent payment of another instalment of the entrance fee to the Nuclear Club. As is well known, the size and number of future instalments is yet to be settled by the founding members of the club.

Scene: breakfast time, 28 December, 1960. Players: A boy of nine, a girl of five, and their father.

Girl (pointing at picture on front page of popular newspaper): Dad, what's that?

Father: It's a picture of a big bomb being let off.

Girl: Why did they do that? Is there a war?

Father: No, they were just trying it to see whether it worked.

Boy (dragging eyes reluctantly from a comic): Who let it off? Was it the Americans or the Russians? They are going to have a war, aren't they?

Father: Well, no. It was the French. And who said the Americans and the Russians were going to have a war?

Boy: I heard it at school. But if there isn't going to be a war why are they putting this picture in the paper?

Father: That's because everybody knew that the Americans and the Russians had bombs, but it's only last year that the French let their first one off.

Boy: They had bombs in the last war, too, didn't they?

Father: Yes, but these are different. They're much bigger.

Girl: Have we got them too?

Father: Yes.

Boy: Then why don't we try them out?

Father: We have done, but for more than two years nobody except the French has been trying out bombs. This is because everybody's hoping that they may be able to agree not to try them out any more, which shows that everybody is trying to see there won't be a war.

Boy: But if the French try them out there's bound to be a war, isn't there? I can't see how they can help it.

Girl: Do they have to try them out to make sure they will work?

Father: Well, that's what the people who make them always say.

Girl: I don't think they should.

Father: Why do you say that?

Girl: It's a waste of bombs.

Trends and Discoveries

New theory of planets from Sun

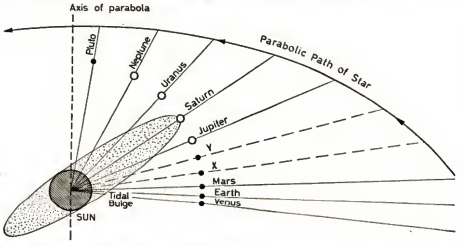
ONE of the earlier theories of the origin of the solar system, now largely abandoned, was that the planets condensed from a single long filament of gas drawn from the Sun by the gravitational field of a star which passed close by. The idea arose from Bode's law which shows that there is a mathematical relationship between the radii of the orbits of all the planets except Neptune and Mercury.

The accompanying diagram illustrates a more plausible modification of this theory suggested by M. M. Woolfson of the Physics Department, Manchester College of Science and Technology (*Nature*, Vol. 188, p. 1179). He proposes that a star, about one tenth the mass of the Sun, approached and passed it on a parabolic orbit. It pulled out a large tidal bulge on the Sun which oscillated with a natural frequency of nearly seven years. Every time the tide reached its maximum, the Sun ejected a mass of gas which became a planet. However, as the star was moving farther on all the time, planets detached themselves at successive positions round the Sun, as the figure shows.

Dr. Woolfson estimates both the tidal bulge and the closest approach of the star to the Sun to be of the order of several thousand million kilometres.

The embryonic planet would start on an orbit which was controlled by the Sun's gravitational field more strongly than by that of the star. Its subsequent motion and orbit would depend on the height of the tidal bulge and its angular velocity, which would increase as the star got nearer to the Sun. The eccentricities of the orbits would eventually be reduced by the friction on the planets of the material surrounding the Sun. This means that they should be smaller for the planets closer to the Sun.

The facts fit these theoretical suggestions very well except in the case of Mercury—Neptune is catered for this time—and in addition the idea predicts two additional planets, X and Y, between Mars and Jupiter. These may subsequently have collided to form the asteroid belt.



Early stages of nitrogen fixation

ONE of the most important processes occurring in nature is the fixation of atmospheric nitrogen into biological materials. Scientists have long known that leguminous plants such as clover, peas, beans, etc., will fix inorganic gaseous nitrogen. This takes place in their root nodules and the agents responsible are bacteria living in these structures. Study on the mechanism of this kind of fixation was greatly facilitated when scientists at the University of Wisconsin obtained fixation in isolated nodules.

However, the reactions which the inert nitrogen gas undergoes in the nodules before it appears in amino acids, proteins, nucleic acids and innumerable other nitrogen-containing compounds in the plant, are still obscure. Using the isotope nitrogen-15, though, biochemists showed that ammonia and two amino acids (aspartic acid and glutamic acid) were probably closely connected with the fixation reactions.

The late N. Bauer of Utah State University recently put forward a hypothesis for the very early stages of nitrogen fixation (*Nature*, 188, p. 471). The root nodules contain iron-proteins related to haemoglobin in blood. Dr. Bauer suggests that atmospheric nitrogen combines with hydrogen on these proteins, resulting in the formation of a temporary compound N$_2$H$_2$. This could then undergo further reactions to give ammonia (NH_3) considered to be the link between inorganic and organic nitrogen. With modern physical techniques it may be possible to detect the production of the short-lived compound N$_2$H$_2$. Till this is done, however, the explanation of the early stages of nitrogen fixation must remain speculative.

Tobacco mosaic virus chemistry revealed

TOBACCO mosaic virus, or TMV, is made up solely of RNA (ribonucleic acid) and protein. The RNA by itself retains all the essential properties of the intact virus, and is able to infect tobacco leaves and cause the replication of many new intact virus particles. The RNA thus contains all the biochemical information necessary for replication and synthesis of the structural protein. H. L. Fraenkel-Conrat, and others of the University of California, have now elucidated the amino acid sequence of the protein of TMV (*Proceedings of the National Academy of Science*, Vol. 46, p. 1463). This protein is made up of subunits consisting of 158 amino acids, and except for a few minor details the order of these residues in the protein molecule has been determined and agrees with the results of parallel experiments carried out at Tubingen University.

TMV protein is not only the first viral protein whose sequence has been determined but also the longest. The hormone insulin and the enzyme ribonuclease, whose structures were published recently, are made up of 51 and 124 amino acids respectively.

This work is of major importance as it should now be comparatively easy to study the effects which alterations in the RNA structure have on the amino acid sequence of the protein. In fact one such observation has already been reported. This type of approach will help to solve the problem of how nucleic acids code information and thus control the genetic make up of living cells.

Snags to open heart surgery

WITH the advent of the heart-lung machine surgeons have restored many cases of congenital heart disease to a normal or near-normal existence. Formerly they would have considered such patients inoperable, because they could not stop the circulation for a long enough period. But the new technique is not yet perfect. A. Silverstein of the Mount Sinai Hospital, New York, remarks that although open-heart surgery with the heart-lung machine may be technically successful at the time, the brain frequently suffers from oxygen lack.

He reports cerebral complications in a third of a series of patients who underwent open-heart surgery at his hospital. There was clear-cut evidence of pathological involvement of the brain either clinically, from electroencephalography, or from post-mortem evidence in those patients who survived the operation but died some time later. Dr. Silverstein states that during the operation there are changes in the electroencephalogram, particularly if it lasts for more than half an hour. The most important factor is oxygen lack while the blood is being pumped artificially round the body. It is hoped that new techniques will overcome this. (*Neurology*, Vol. 10, p. 987.)

Topics from the President's Report, Carnegie Institution of Washington, 1959-1960.

The most distant view ever

IN the field of astronomy R. Minkowski succeeded in photographing the most distant object ever seen. This corresponds in position with a part of space from which scientists, both at the Cavendish Laboratory, Cambridge, and at the California Institute of Technology Owen's Valley observatory, had previously observed radio emission.

It is a cluster of galaxies which appears to be receding at nearly half the velocity of light away from the Earth. That this forms a radio source is probably due to collisions between the component galaxies as in the source Cygnus A, which, however, is estimated to be about eight times closer than Dr. Minkowski's object. The absolute distance of the cluster is uncertain but is of the order of thousands of millions of light years. W. A. Baum measured the magnitudes of the separate galaxies within the cluster, and confirmed spectral observations of Dr. Minkowski indicating that one of the brightest of these was the radio source. They carried out this work at the Mount Wilson and Mount Palomar observatories. The picture of the distant cluster was obtained with the 200 inch Hale telescope.

H. W. Babcock measured the strongest naturally occurring magnetic field. The star (HD 215441) has a fluctuating field, which at one time in its variation has a value of 34,400 gauss. (The Earth's field is only about half a gauss and large sunspots have fields of almost 4,000 gauss.) This discovery may induce theoreticians to reconsider the importance of magnetic effects in ideas about the structure of stars.

A group of scientists under J. L. Greenstein has found more stars with atmospheres having chemical compositions very different from that of the Sun or its neighbours. The abundance of the light metals lithium and beryllium fluctuated heavily by factors even greater than a hundred. One star had a hundred times more phosphorus than the Sun. Studies like these, of course, help to increase our knowledge of the structure and fundamental processes of the universe.

Geological ages, pressures and processes

CURRENT theories on geophysics suppose that the lower part of the Earth's crust and the underlying mantle are composed of the iron-magnesium silicate olivine. F. R. Boyd and J. L. England, of the Institution's Geophysics Laboratory, compressed the iron-rich variety of this mineral at a high temperature and a pressure of 60,000 to 80,000 atmospheres and thus contrived to change it into the denser crystalline form spinel. These results indicate what may happen in the Earth's mantle at a depth of 400 kilometres where seismic measurements have shown that there is a sharp density discontinuity.

The same pair of scientists have also managed to synthesize industrial quality diamonds from graphite, under a pressure of 75,000 atmospheres and a temperature of 1500° C. This achievement is similar to the one by the General Electric Company in 1955, but here has academic significance for the understanding of geological processes.

Among other studies this laboratory has continued to work on the radioactive dating of rocks, as has the Department of Terrestrial Magnetism. Long term diffusion of the products of radioactive decay is now established as the reason for discordant values between the various independent radioactive methods. One of the most important geophysical points to clear up is whether or not mountain building is a continual or spasmodic process, and whether or not it has occurred simultaneously in all continents. Radioactive clocks appear to be disturbed by mountain building and the current work may ultimately lead to more reliable answers in this field.

Geologists are always on the search for quantitative ways of making their observations. One important requirement of this kind has been the desirability of finding a reliable natural pressure indicator for rocks. H. S. Yoder and his colleagues have shown that the solid solution of the mineral series almandite-pyrope-garnet may possibly provide one of these systems if the local rock temperatures can be estimated.

RNA, DNA, immunology and photosynthesis

THE Biophysics Section of the Institution of the Department of Terrestrial Magnetism, Washington, has continued fruitful research along a number of different lines. R. B. Roberts and his associates separated ribonucleic acid (RNA) from the so-called ribosomes in the bacterium *Escherichia coli*. These are intracellular particles which seem to be connected in some way with the cellular metabolism. Large molecules of the RNA could be broken up into units (called 4S units) a twentieth or one-fortieth their size, and the biologists found that these also occurred naturally in the cells. Further radioactive tracer work showed that the 4S units may be the basic "bricks" which build up the protein and RNA molecules during synthesis.

A. D. Hershey and his team in the Genetics Department analysed deoxyribonucleic acid (DNA) from a bacteriophage and succeeded in identifying half and quarter molecules of this substance. From the molecular weights of these they deduced that a particle of bacteriophage (T2) contained two molecules of DNA, each with a molecular weight of about 50 million. The chromosome of the phage may consist of either or both of these molecules. B. P. Kaufmann and his co-workers showed that a chemical agent, the enzyme deoxyribonuclease, could produce genetic mutations in *Drosophila melanogaster*. He suggests that even mild chemicals produced in cells may have similar effects.

In the Department of Embryology, Baltimore, J. D. Ebert and L. E. DeLanney, in some immunological work involving the grafting of tissues from chicken spleens, concluded tentatively that cells of both the donor of the graft tissue, and the recipient host, played a part in the immune reaction. The host cells, however, were numerically the most important.

Studies in the mechanism of photosynthesis have continued in the Department of Plant Biology. It has been shown that two parts of this chemical process are supplied with energy absorbed from the sun by quite different pigments. The work of Abelson and Hoering (*New Scientist* Vol. 8, p.1544) at the Geophysical Laboratory, on the preferential fixing of carbon isotopes by plants, is also continuing.

Keeping sperms at ordinary temperatures

BULL sperm kept in the dark at room temperature for 1-6 days in a diluent containing sodium citrate, coconut milk, a little egg-yolk and some antibiotics gave as good a conception rate as sperm refrigerated at 5° C in coconut milk and glycerol (C. Norman and others, *Anatomical Record*, Vol. 137, p. 384). The team of scientists from West Virginia University who did this work have now succeeded in maintaining human sperms at room temperatures in a chemically defined medium (C. Norman and others, *Nature*, Vol. 188, p. 760).

They separated sperms from seminal fluid by centrifuging, and then diluted them with a solution called Medium 199. They added antibiotics and a fungicide, and kept the sperms in the dark in small plastic vials, recording daily their ability to move, and the proportion remaining alive. The number of live and reasonably mobile cells remained relatively steady for up to five days. The solution was buffered to keep the pH of the suspension constant, and the team found that a "tris", or phosphate buffer, gave better results than a bicarbonate-carbon dioxide buffer. This contrasts with the results of an Indian zoologist working on the same problem at Illinois University who found that gassing an entirely chemical sperm diluent with carbon dioxide was an important factor in preserving the life and fertility of bull sperms (U. D. Sharma, *Journal of Animal Morphology and Physiology*, Vol. 7, p. 37).

Further research along these lines will be of importance in two different fields. Preservation of bull sperms at room temperatures is likely to be useful in artificial insemination studies, and as regards human sperms, these techniques will allow investigation of the metabolism and functioning of young and old human cells under conditions more closely defined and controlled than has been possible till now.

Books

Touch and sight in the perception of space

by Sir Stewart Duke-Elder

Space and Sight. By M. von Senden. Methuen & Co., 348 pp., 42s.

FOR centuries the nature of spatial perception, and indeed of all perception, has intrigued philosophers; it is a subject in which it is notoriously difficult to attain finality. It is not unexpected, therefore, that two schools of thought exist—the nativistic, which claims that perceptual processes are basically intuitional, received by us as a legacy at birth, and the empirical school which insists that all ideation is laboriously built up by experience. The intellectual controversy engaged the attention of such early philosophers as Descartes, Locke, Leibnitz, Berkeley, Hume and Kant, and in the field of visual perception the two sides were energetically defended a century ago by Hering and von Helmholtz.

It might be thought that the matter could well be put to a practical test. It was first suggested to Locke by his Irish friend, William Molyneux, in 1690, whose blind wife probably led him to think on these lines, that an answer could be derived from the observation of the reactions of persons born blind if they had been suddenly made to see by a surgical operation. On acquiring the sense of sight for the first time, would such a person recognize objects by sight which he had hitherto known through touch alone, would he be able to interpret what he saw, or would the spatial aspects of seeing be something outside his ken to be learned like a new and strange language?

Von Senden has diligently studied the reports of 58 out of the 66 cases of this nature found in the literature, and from the study he emerges a complete empiricist. There is no doubt that the performance of such a person to whom sight has suddenly been given is poor, and that he has great difficulty in translating a world explored by the tactile and kinaesthetic senses into the terms of a new world spread before him by his visual sense. From this von Senden argues that an awareness of space cannot be acquired by the tactile sense alone; but could this not be interpreted merely as a demonstration of the indisputable fact that feeling and seeing are quite distinct? It could be argued that a blind man has a spatial world although of dimensions peculiar to itself wherein space is limited by an arm-span or the counting of steps, and it is not surprising that the translation of this into the wider spatial world of vision is difficult. Moreover, many of the cases quoted in the literature have been poorly reported, particularly from the psychological point of view, and none has been adequately analysed and studied before and after the intervention of surgery. It is to be expected, therefore, that many of them are contradictory in their findings. It is unlikely that many such cases will be recorded in the future, owing to the ready access of most communities to early surgery, so that the sources of information of this nature will probably never be greatly increased.

Von Senden makes a good case for his point of view, but it cannot be said that it is absolutely convincing; moreover, the three authorities who contribute appendices —a philospher, a zoologist and a psychologist—do not find it so. There is no doubt whatever that the more refined aspects of visual spatial discrimination depend on learning, but with the evidence presented the philosophical question as to whether all spatial appreciation is derived in this way remains unanswered. It may well be that neither an out-and-out nativism or empiricism can meet the case.

Tales, marvellous tales

The Fifteen Wonders of the World. By René Poirier. Translated by Margaret Crosland.
Gollancz, 400 pp., 25s.

FOUR hundred pages, fifty-four plates, fifty-four line drawings and diagrams in the text —no one can complain that this book fails to give value for money. It is the literary equivalent of one of those bargain price coach tours arranged by enterprising travel agencies. M. Poirier enthusiastically whirls us along through time and space: "On my right the pyramids, on my left the Great Wall of China" and so on past the Palace of Versailles, the Atlantic Cable, the American Transcontinental railway, the London Underground, the Forth Bridge, the Eiffel Tower, the Panama Canal and the Simplon Tunnel until he finally lands his passengers, somewhat breathless and bewildered at the Oak Ridge Atomic Power Project.

On intensive sight-seeing tours of this kind the passenger feels stunned by the eloquence of his guide and it is only afterwards that he begins to ask himself uneasily: "Was he *really* right about that? If not, was he wrong or did that nice interpreter, Miss Crosland, mistranslate his meaning?" In this case our suspicions are aroused when we find an early print of Sir Marc Brunel's Thames Tunnel (opened 1843) reproduced over the caption: "An entrance to a Metropolitan Railway station about 1870." They are confirmed by a fanciful picture of an early American rack train on a vertiginous gradient presented to us as a scene on the Transcontinental Railway. Marc Brunel is confused with his son Isambard, a mistake which no Frenchman should make, while Sir Daniel Gooch receives no mention in the chapter on the transatlantic cable though he was awarded a baronetcy for the great part he played in that venture.

Such criticisms may sound captious, but these are not isolated faults. M. Poirier has taken a lot of trouble as his list of sources shows, but the truth is that unless a writer approaches his subjects with some foreknowledge and sound technical equipment, even the best authorities may mislead him, nor can he judge which *are* the reliable authorities. That is the great risk in writing a book of this kind. The total result in this case is very readable and many of the illustrations are fascinating but, like our daily newspaper, too great a reliance should not be placed on its factual accuracy.

L. T. C. ROLT

15 volume encyclopaedia

McGraw-Hill Encyclopedia of Science and Technology.
McGraw-Hill, 15 volumes, £67 16s. 6d.

THIS 15 volume encyclopaedia contains over 9,000 pages, 9,300 illustrations and 7,200 articles on all aspects of the life sciences, physical sciences, Earth sciences and engineering. It was compiled primarily in America, with a distinguished editorial advisory board, but its contributors are drawn from a wide variety of nations. To review its contents would require a panel of reviewers almost as large as the panel of contributors; but it may be said that the work is well laid out in the American style of typography, with some attractive colour photographs, good line drawings and not very well reproduced black and white photographs. It would be surprising if those who can afford the set do not find it very useful.

T. R.

CONTRIBUTORS

Alexander Duncan Baxter (*Towards giant space vehicles*) was educated at Liverpool Institute High School and at Liverpool University, where he graduated in mechanical engineering. After gaining experience in various engineering organizations he joined the Royal Aircraft Establishment in 1935, becoming superintendent of the Rocket Propulsion Department in 1947. He was then appointed Professor of Aircraft Propulsion at the College of Aeronautics, Cranfield. In 1957 he joined the de Havilland Engine Company as chief executive of the Rocket Division and Nuclear Power Group, becoming a director of the company a year later. He is married and has a son and two daughters. His leisure pursuits are fell-walking in the Lake District and ciné-photography. (*pages* 19-21)

Bertram Vivian Bowden (*Britain's backwardness in higher education*) was educated at Chesterfield Grammar School and Emmanuel College, Cambridge, where he worked under Rutherford. He was then a physics master until the second World War, when he was employed on radar research in Britain and later in the United States. After the war he spent three years with Sir Robert Watson & Partners, and three with Ferranti Ltd. on digital computers, before becoming Principal of Manchester College of Technology in 1953. He is the author of *Faster than Thought*. (*pages* 22-25)

Christopher John Duncan (*The search for a chemical "scarecrow"*) was educated at Trinity School of John Whitgift, Croydon, and Queen Mary College, University of London. In 1958, after two years as a Civil Service Research Fellow at the Physiological Laboratory, Cambridge, he was appointed to his present post of Lecturer in Zoology at Liverpool University, where he also works on the sense of taste in birds and on molluscan physiology. He is married, with one son, and is a keen yachtsman. (*pages* 26, 27)

George Frederick Humphrey (*The unknown Indian Ocean: an international survey*) was educated at Sydney University and at the University of Cambridge, where he gained his PhD degree. In 1956 he was appointed chief of the Division of Fisheries and Oceanography at the Marine Laboratory of the Commonwealth Scientific and Industrial Research Organization, Cronulla, NSW. He is also President of the Special Committee on Oceanographic Research of the International Council of Scientific Unions. Dr. Humphrey is married and has a daughter. His main leisure interest is music. (*pages* 36-38)

George Anthony Hoffman (*What can we do with whiskers?*) was educated at Harvard University and was a lecturer at the University of California, Los Angeles, from 1951 to 1959. During this time, in 1954, he was appointed engineer with the RAND Corporation, a post he holds at present. Last year he was also appointed Director of the Consumers' Union of America. His work is concerned with the materials and structures of flight vehicles, the engineering aspects of urban transportation and consumer goods evaluation. He is a member of the American Rocket Society and of the Institute of Aerospace Sciences. (*pages* 40-42)

Stewart Duke-Elder (*Touch and sight in the perception of space*), Surgeon-Oculist to the Queen since 1952 and formerly to King George VI, has held many consultant and advisory appointments as an ophthalmic surgeon in addition to his work at St. George's Hospital, London, and as Director of Research at the Institute of Ophthalmology, University of London. His many books include *Text-book of Ophthalmology*, the seven volumes of which appeared in the course of 22 years, *Diseases of the Eye* and *Century of International Ophthalmology*. He was knighted in 1933. (*page* 46)

Thomas Hay O'Beirne (*Puzzles and paradoxes*) has been since 1949 Chief Mathematician with Barr & Stroud Ltd., of Glasgow, who are precision optical, mechanical, electrical and electronic engineers. He was born in 1915 and educated at Hillhead High School, Glasgow, and at Glasgow University, and studied Latin and Greek before changing to mathematics and physics for his degree. During the war years he served in the Royal Naval Scientific Service, principally at the Admiralty Compass Observatory, Slough. He was scientific adviser to the Ordnance Survey of Great Britain from 1947 to 1949. He is a member of the Council of the British Computer Society and vice-chairman of its Scottish branch; has been a Fellow of the Institute of Physics since 1948 and was honorary secretary of its Scottish branch 1953-56; and is a Fellow of the Institute of Navigation. In spite of his name, Mr. O'Beirne is a Scot, and his wife is, like himself, a graduate of Glasgow University. They have two daughters. He reads light verse, plays and detective fiction, and can sometimes be induced to work in his own garden, when not inventing puzzles. (*pages* 48, 49)

Puzzles and paradoxes

by T. H. O'Beirne

1: *"Laetitiae causa"*

AT the start of a new weekly series, it seems only fair to give prospective readers some idea of what type of material they may expect to find regularly in it. The first article is a natural place to look for an indication of the author's philosophy, policy, idiosyncrasies or just plain prejudices. Here this has the further advantage of employing the space which in later articles will make reference back to the discussion or problem of the previous week.

To begin with our main title: a puzzle will mean any problem whose method of solution is not (we will hope) immediate or obvious; and a paradox will mean something whose truth and explanation can be established only in the face of some initial sales resistance. Interpreting these terms liberally, we hope to range over the whole field of what are sometimes known as mathematical recreations.

Many readers will already know what this implies. Others may welcome the assurance that we shall think we have failed if they cannot find this attractive and comprehensible on a basis of something like higher school mathematics. (We may permit an occasional aside intended for the expert, provided that others can skip this without undue sense of loss.)

Those who feel seriously interested in this series are advised to keep earlier articles for possible reference later. We shall try to vary the types of problem from week to week, and when we return to a given type, we may well wish to make reference to the discussion of an earlier problem.

Squared paper will often be a convenient aid, and we shall assume that readers will have it available. We may at times want figures drawn and cut out from cardboard or paper, possibly to be coloured, and counters or pieces may be wanted for games or other problems. More rarely we might describe something three-dimensional needing some form of handicraft work for its full enjoyment.

We hope to have prize competitions from time to time, where added credit will be awarded for brevity, completeness and elegance of the solutions.

We are not attracted to puzzles whose only interest lies in the arbitrary multiplication of complications. (In this last sentence the operative words are "only" and "arbitrary".) These we consider lacking in an essential element—charm, elegance, beauty, aesthetic appeal—in regard to which we hope to find common ground with our readers. Correspondence is invited, and suggestions will be welcome.

To some, we are aware, the idea that recreations can be mathematical—or mathematics a recreation—may itself be the supreme puzzle or paradox (though perhaps there will be fewer of these readers here than might be elsewhere). We hope to convert even some of these. Quite a few recreations are "mathematical" by courtesy only—the real need may only be for careful logical reasoning of the type which can form part of the attraction of a good detective novel.

Our primary purpose will indeed be recreation or diversion —and we will hope to give something that all can read, hoping that many will go on to occupy an idle hour (or several) on some of the problems we shall set.

Not everyone, we know, finds mathematics an immediately attractive subject of interest. Some will admit that it may be important, and perhaps engrossing, to those who apply it in science, industry, commerce or finance. Many will assert that they themselves are "hopeless" at mathematics.

This seems doubly wrong, and more than a pity. The truth is that the true mathematician pursues beauty as much as—or more than—utility. It may be an austere form of beauty, like the clear, hard appeal of a diamond, but it is there. As with many forms of beauty, those who appreciate it have a strong urge to bring others to share their experience, in what measure they can.

This may be easier than many think, and recreational material may be the thin end of the necessary wedge. We feel that many people are non-mathematical only for lack of suitable bait at the appropriate time—school, or later.

We think how often we have heard the complaint ". . . so then he showed us the solution and we could see it was right, but what we couldn't see was how anyone could ever be expected to think of it". This is common with geometrical deductions when the proof begins with drawing an additional line in the figure.

Our attitude is that in these cases there *is* a reason, and one which can—and should—be explained. Failing this the only

education is self-education—possible, but unnecessarily laborious; and perhaps not possible unaided for some who could nevertheless be taught.

There is, we believe, a science of "heuristics"—the science of finding out. It is rarely taught explicitly as such, but successful inventors and problem solvers, at all levels, must acquire it, consciously or otherwise.

Believing this, we promise to do what we can to indicate not merely the solutions to our problems, but as far as possible the way in which these solutions naturally present themselves. We would sooner have our readers say, "Of course! Why didn't I think of that for myself!" than "If this is what you've got to do, it's obviously far beyond me!"

Many problems of quite surprising apparent difficulty can be solved by the simple method of saying, "Can I go forward at all from what I already know?" In some cases this has to be supplemented by, "If I had got the problem solved, what else would this imply?" Sometimes one of these lines carries straight across the gap between the known and the unknown. Sometimes the two meet to form a bridge in the middle.

We can promise a fair volume of original material, but we shall frequently consider celebrated problems already treated elsewhere. These may be new to some readers, and we may find something new to say of some of them.

For our first problem we take one which is about 1200 years old, and state it in the words of Charles Hutton, LL.D, FRS, Professor of Mathematics in the Royal Military Academy, Woolwich, who in 1803 included it in the first of his four volumes of *Recreations in Mathematics and Natural Philosophy*:

Three jealous husbands with their wives having to cross a river at a ferry, find a boat without a boatman; but the boat is so small that it can contain no more than two of them at once. How can these six persons cross the river so that none of the women shall be left in company with any of the men, unless when her husband is present?

This is translated from the *Problèmes plaisants et délectables* of C.-G. Bachet, Sieur de Méziriac, first published at Lyons in 1612. (This work had a new edition only last year.)

The problem is most probably the work of one or other of two celebrated Englishmen. It appears early in the ninth century AD, attributed (probably spuriously) to the Venerable Bede. It is included with more plausibility in the *Works* of Alcuin the Northumbrian, whose Letter LXXXV to his pupil, the Emperor Charlemagne, accompanied "some examples of subtlety in Arithmetic, for your enjoyment". "*Laetitiae causa*" are the exact words which we have translated as "for your enjoyment" – an excellent motto to begin our series.

It is fair – and perhaps enough – to remark that in its original form our problem reflected the dangers and crudities of contemporary behaviour in a way which Bachet evidently thought unsuitable for the polite society of 17th century France.

This problem seems appropriate in more senses than one after our remarks about spanning gaps between the known and the unknown. Those who solve it should be able to prove that four or more couples cannot impose similar restrictions and still cross the river.

LETTERS

Radio source galaxies

Sir,—The suggestion made in a recent letter from L. S. Harley ("*Collision" in Cygnus*, 22 December), that peculiar galaxies emitting an abnormal amount of radio radiation may arise not from the collision of two galaxies but from the fission of one, is one of topical interest: the idea has attracted some attention in the last year or two. In particular it has been advocated strongly by Professor Ambartsumian of the Burakan Observatory, Armenia, who summarized his views in a paper communicated to the eleventh Solvay Conference (on the structure and evolution of the Universe, Brussels 1958), and also in his more recent George Darwin lecture to the Royal Astronomical Society. The reasons for holding this view (which is by no means generally accepted) are however certainly not those proposed by your correspondent.

Our understanding of the nature of the radio source galaxies is very limited at present. We do not understand in detail the mechanism by which the radio radiation is produced in a given object; among the surprising diversity of objects that are sources there are possibly three or four recognizably different classes of galaxy; and if radio emission is a stage in the evolution of a galaxy or pair of galaxies we do not know enough about the evolution of galaxies to say what stage it might be. About 30 per cent of the accurately measured and suitably placed radio sources can be identified with visible galaxies, and of these a significantly large fraction seem to consist of two or more otherwise normal looking elliptical galaxies (spheroidal aggregations of stars lacking interstellar dust and young highly-luminous stars) close together in space. Ambartsumian argues that such galaxies are too numerous to be chance collisions, and must rather have a common origin.

The galaxy illustrating Mr. Harley's letter is *not* the Cygnus-A galaxy, but the much nearer galaxy NGC5128 that is the intense radio source in Centaurus, and neither of these two unusual galaxies belongs to the class just described. It seems certain that the dark rift in NGC5128 is obscuration caused by interstellar dust analagous to that in a normal spiral galaxy, though its unusual association with an elliptical galaxy and the curious symmetry remarked by Mr. Harley have caused speculation that the obscuring matter is of different origin. Since the light of the two "halves" of the galaxy comes neither from a disrupted single solid body, nor from interstellar gas, but from stars, the difficulty in the hypothesis (and to some degree in Ambartsumian's) is to propose a mechanism by which the stars could be sorted out into two separate star

systems both consisting apparently of old stars.

It should be mentioned also that the radiation from this galaxy, and all other radio source galaxies, is not 21 cm line emission, which arises from neutral atoms of interstellar hydrogen, but non-thermal continuous radiation whose intensity increases with wavelength through the observable range from a few centimetres to a few metres.

D. W. DEWHIRST.

The Observatories,
Cambridge.

Insecticides inside cattle

Sir,—With reference to your item "Insecticides inside cattle" (*Trends and Discoveries*, 8 December), the animal systemics ronnel (Trolene, Etrolene, etc.) and Co-Ral have been in commercial use for some time in the United States and elsewhere. In the United Kingdom they have been used on a commercial basis for about a year.

Indeed, it has recently been proposed that they could be used to eradicate the warble fly from this country provided that all livestock owners could be persuaded to use them. In addition they have been sufficiently used to have been given a BSI Recommended Common Name; thus Co-Ral is named coumaphos and Etrolene termed fenchlorphos.

A. K. PALMER.

36 Clarges Street,
London, w1.

Plant growth

Sir,—Can any of your readers enlighten me as to why, if a pure strain tall plant is crossed with a pure short plant, the resulting hybrids will all be tall, as tall is dominant over short? If the hybrid plants are self-fertilized the result will then be three-quarters dominant or tall plants, and one-quarter short, or recessive plants, but there will be no plants of an intermediate size?

Z. C. MACDONELL (MRS.).

33 Belmont Rise, Cheam,
Sutton, Surrey.

Bykov's treatise

Sir,—In *Notes and Comments* (15 December, page 1,572) you state that Bykov's treatise on *Internal Conditioning* has not been published in Britain or the USA.

I presume the treatise in question is the following:

Bykov, K. M.: *Cerebral Cortex and the Internal Organs* (edited and translated by W. H. Gantt), published in 1957 by the Chemical Publishing Company of New York.

K. R. L. HALL.

Department of Psychology,
University of Bristol.

Cold-blooded operations

Sir,—Is the technique reported in *Trends and Discoveries* (21 December) of producing low temperature in patients for brain and head surgery without "immersing the patient in an icy-cold bath" so very new? It is a number of years since Delorme in Edinburgh and Ross at Guy's Hospital described methods of leading the blood from the great veins into an external cooler and pumping the cooled blood into the great arteries, so that the head was by-passed (see for example Ross DN, 1954, *Lancet I* 1108). Work is also being done at Hammersmith, Westminster and Great Ormonde Street Hospitals on this method of cooling.

Another way of avoiding the "icy-cold bath" was also described in 1954; this is internal cooling by circulating cold water through an intra-gastric bag, a method which has been greatly improved by ingenious machines (e.g. Khalil HH, 1958, *Lancet I*, 1092).

RONALD MACKEITH.

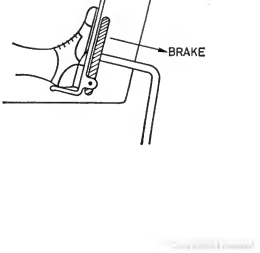
35 Bloomfield Terrace,
London, SW1.

Dual pedal driving

Sir,—Mr. Saunders's two-pedal system (*Letters*, 29 September) interested me, so I tried it on my car. By fitting a hinged plate to the brake pedal the drawbacks mentioned by Mr. Saunders have been eliminated, whilst improved stopping has been retained.

J. DAVIES.

Epsom, Surrey.



The Loch Ness Monster

Sir,—We cannot allow Dr. Burton's letter (8 December) to pass without comment. Remarkable as it may seem, Dr. Burton appears to have completely misunderstood the thesis of our letter published on 24 November.

The crucial question in any discussion of gas-filled vegetation as an explanation of the Loch Ness Monster is to decide whether or not it can explain the rapid directional surface movement frequently associated with sightings of the Monster.

If it is assumed that gas is the raft's sole propulsive agent, it follows that the larger the gaseous cargo the farther the raft will move. The absolute quantity of gas required to lift the raft will depend on the depth at which it forms: the greater the depth, the higher the pressure and hence more gas must be produced to occupy any given volume. As the raft approaches the surface, the gas will expand, and for a given object the final volume of gas, and hence potential for surface movement, will be proportional to the depth at which the raft formed. In practice, this will only be approximately true owing to the loss of gas as the object rises to the surface, but it is conceivable that throughout the upward journey all the gas is held compressed within the raft, expansion occurring solely at the surface. These conditions are ideal and should give the maximum surface movement possible. The points to note are that this movement will be greater the deeper the raft formed and that for Loch Ness, whose maximum depth is 700 feet, the calculated movement is at least two orders of magnitude different from the observed phenomena.

When looked at logically, Dr. Burton's arguments about "shelf", etc., claimed by him to invalidate our theoretical discussion, tend more to refute the "raft hypothesis" rather than vindicate it. If Dr. Burton had told us that parts of Loch Ness were greatly in excess of 700 feet we might have been temporarily impressed, but to claim that much of Loch Ness is "shelf"—which, incidentally, is not supported by our own echo-sounding data—and to claim that this immediately invalidates our arguments is astonishing.

Equally astonishing is the explanation given by Dr. Burton to account for the difference in behaviour between his small models and ours. He states: "I used a natural gas." Is not carbon dioxide a natural gas? Admittedly the gas presumably involved in bringing objects up from great depths is methane; but in any discussion of algal sheets carbon dioxide is very relevant. A more likely explanation of the observed differences between Dr. Burton's and our models is that Dr. Burton provided his models with a continuous supply of gas, whereas we did not. If this was the case, Dr. Burton's models were not strictly analogous to the problem under consideration and so lose much of their value.

In conclusion, we submit that Dr. Burton has failed to produce any evidence against our theoretical arguments, and until such evidence is forthcoming we can but reiterate our previous views—namely that the gas-filled vegetation hypothesis is incapable of explaining all the observed phenomena associated with sightings of the Loch Ness Monster.

PETER F. BAKER.
MARK WESTWOOD.

Emmanuel College,
Cambridge.

Sir,—Most of the facts and figures quoted in Dr. Burton's reply to Peter Baker seem to me to have no bearing on the controversy.

Anything on Loch Ness, whether vegetable-mat, monster or just mere ghost, is most likely to be seen near a river mouth because that is where the houses are and the people to see it. Mats or monsters within 2-300 yards of the shore can, presumably, be described and their position estimated with more certainty than objects farther away.

Dr. Burton's estimate that there is an even scatter of sightings over all the hours of daylight has implications, however. From this it is a fair deduction that mats, monsters, etc., have a special liking for the earliest hours of the day, as, for most of the year, there is practically no one about on the loch side at dawn or for some hours afterwards.

Somehow experiments with tanks, "natural" gas and locustrine deposits conjure up for me a world of make-believe. One wonders whether Dr. Burton is not trailing the tail of his coat. But then, of course, I am prejudiced. Having lived near the loch for almost a quarter of a century, I *know* that strange animals have their homes in Loch Ness, and that no angler, ghillie or other local resident has seen a vegetable-mat floating on the surface—an occasional branch or tree trunk, yes, but a gas-filled mat, never.

CONSTANCE WHYTE

North End,
Ditchling, Sussex.

Inferior man and superman

Sir,—Taking a detached viewpoint of present observable tendencies, I suggest that the ultimate purpose behind the production of mutation forming radiation, provided that it does not become so concentrated that life becomes extinct, is that of an agent for the acceleration of the evolutionary process.

The increasing number of mutations caused by radiation would not necessarily all be of a negative nature. It would be reasonable to assume that half the variations on man as he is at present would result in an inferior being and half in various improvements. This process could result in the splitting up of the species into two subspecies, one a harmless inferior type, and the other a kind of superman. The mentally superior would dominate and would, we hope, be blessed with the power to control himself and his evolutionary methods.

JOSEPH R. PENDLE.

21 Lorne Road,
Wealdstone, Middlesex.

Rhubarb! Rhubarb! Rhubarb!

HAVE you ever realised just how much people categorise you by your garden? They may have no idea whether you are an introvert or an extravert, but they soon notice when you stop running your garden, and start running away.

And honest spadework is by no means enough, if you wish to present a good face (or garden) to the world. Planting the wrong thing is worse than planting nothing at all.

Every plant, however attractive when young, can bring disgrace. It may grow up to be a weed. Or, far more humiliating, it may turn out to be the wrong sort of rhubarb. Consider the following passage by Lawrence D. Hills in his regular gardening feature *Down to Earth* in The Observer:

> 'Early Albert is easy and true from seed, so more plants raised cheaply in this way will provide alternate rows that can be rested after forcing. Real enthusiasts will prefer Glaskin's Perpetual.'

The rhubarb in my garden is always resting, and I'm quite sure it isn't Glaskin's Perpetual.

But this is the encouraging thing about the *Down to Earth* column. Himself a Glaskin's Perpetual man, Mr. Hills has a great deal of patience with the reluctant gardener. He is full of good ideas about what to plant, and when, and how. He makes sure you get this advice in plenty of time. And somehow he manages to keep jargon out of these helpful technicalities.

The Observer gives you a sort of defence in depth against the traps of gardening. Victoria Sackville-West writes lovingly of flowers in her column. She identifies closely with them, is very much alive to their beauty, and yet she too is thoroughly down to earth. She knows the dangers of slugs and snails, frosts and gales. She too sings the praises of bone meal, dried blood and muck.

Like Mr. Hills, she has the happy knack of being able to write interestingly about her enthusiasm.

And there's one other good thing about these columns. While you're reading them, you are—it can be argued—actually gardening. So if your conscience (or somebody) suggests that you ought to be out there doing something, here is a very good reason for putting off the evil moment, possibly for ever. **J.B.L.**

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OFFICIAL APPOINTMENTS

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CHEMIST required at Warren Spring Laboratory (D.S.I.R.), Stevenage, Herts, as SCIENTIFIC OFFICER or SENIOR SCIENTIFIC OFFICER, for work on chemical methods for extraction of metals from ores, involving both fundamental studies and problems arising from applied work on specific ores, e.g. use of complexing agents for liquid/liquid extraction of metals and studies of chloridising and chlorinating reaction mechanisms. Candidates should have a preference for fundamental research. Qualifs: 1st or 2nd Class Hons. degree in Chemistry. Some experience with chemistry of metal/organic compounds desirable. Age at least 26 for S.S.O. and at least 3 years' post-grad. experience required. Salary—S.O. £690-41,144. S.S.O. £1,250-£1,540. Forms from Ministry of Labour, Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting ref. F.905/OA.

EXPERIMENTAL OFFICERS: MINISTRY OF EPOWER. 2 pensionable posts at Safety in Mines Research Establishment, Sheffield, for men or women at least 26 and normally under 31 on 31.12.61. One post is concerned with the ignition of inflammable gases by electric sparking and involves construction, testing, and use of electronics apparatus for the investigation of electrical discharges and the flames initiated by them; the other is concerned with the design, construction, installation, and calibration of a wide variety of electronic measuring apparatus. Qualifications: H.N.C. or equivalent, in applied physics or electrical engineering, and at least 3 years' experience in the design, construction, and testing of equipment in one or more of the following fields: electronic pulse circuits, servomechanisms, small mechanisms, electronic computers, pulse-frequency equipment. Knowledge and experience of use of transistors desirable but not essential. Salary scale £1,045-£1,285. Promotion prospects. Write CIVIL SERVICE COMMISSION, 23, North Audley Street, London, W.1, for application form, quoting **S/94-95/61/SMRE.** Early Application advised.

UNIVERSITY OF NEW ENGLAND
Armidale, New South Wales

LABORATORY TECHNICIANS

Applications are invited for two positions of Laboratory Technician in the Faculty of Rural Science:

DEPARTMENT OF PHYSIOLOGY
Experience of laboratory procedures in haematology is desirable but not essential. The main research interest of the department is the physiology of erythrocyte. The successful applicant will have a responsible position in the team.

DEPARTMENT OF LIVESTOCK HUSBANDRY.
The Technician will be primarily responsible for the development and maintenance of a fleece measurement laboratory under the guidance of Dr. M. L. Rendel. He will be expected to assist with class preparations and research into wool growth, involving histological techniques. Experience in this field is desirable but not essential.

The commencing wage will be fixed according to qualifications and experience up to £A26.5.9. per week (males) and £A22.8.10 (females) subject to future variation in the basic wage. Four weeks' annual leave. Fares will be paid and removal expenses up to £A200. Laboratory technicians may enrol for a part time B.Sc. degree

Applications from within Australia and New Zealand should be forwarded to reach the Registrar, UNIVERSITY OF NEW ENGLAND, Armidale, N.S.W., Australia, not later than 10th **FEBRUARY, 1961**; applicants outside Australia and New Zealand should forward their applications to the Secretary, ASSOCIATION OF UNIVERSITIES OF THE BRITISH COMMONWEALTH, 36 Gordon Square, London, W.C.1, by the same date. In the case of these candidates an additional copy should be forwarded to the Registrar, by air mail if necessary. Applications should give full particulars of qualifications and experience, together with the names of two referees.

THE UNIVERSITY OF LEEDS
Department of Mathematics

Applications are invited for appointment as LECTURER or ASSISTANT LECTURER in Pure Mathematics at a salary on the scale £1,050 x £50-£1,400 x £75-£1,850 (efficiency bar at £1,550) a year for a Lecturer, or within the range £600-£950 a year for an Assistant Lecturer, according to age, qualifications and experience. Applications (three copies) stating full details of qualifications and experience, together with the names of three referees, should reach the Registrar, The University, Leeds, 2 (from whom further particulars may be obtained) not later than 7th February, 1961; candidates overseas may apply in the first instance by cable, naming three referees, preferably in the United Kingdom.

UNIVERSITY OF SYDNEY
CHAIR OF METALLURGY

Applications are invited for a recently established Chair of Metallurgy within the Faculty of Engineering. The successful applicant will be responsible for the teaching of, and research in, Metallurgy and Metallurgical Engineering.

Salary will be at the rate of £A4,250 per annum, plus cost of living adjustments. There is retirement provision under either the Sydney University Professorial Superannuation Scheme or the New South Wales State Superannuation Scheme.

Under the Staff Members' Housing Scheme, in cases approved by the University and its Bankers, married men may be assisted by loans to purchase a house.

The Senate reserves the right to fill the Chair by invitation

A statement of Conditions of Appointment and Information for Candidates may be obtained from the Secretary, ASSOCIATION OF UNIVERSITIES OF THE BRITISH COMMONWEALTH, 36 Gordon Square, London, W.C.1.

Applications close, in Australia and London, on 15th **MARCH, 1961.**

UNIVERSITY OF DURHAM
SECOND CHAIR OF GEOLOGY

APPLICATIONS are invited for a Chair of Geology tenable in the Newcastle Division of the University. This is a newly established post and will be the second Chair of Geology in the Department at Newcastle. The successful candidate will be required to take up duty on the 1st August, 1961 or such other date as may be arranged. Salary in accordance with the Professorial scale (£2,600-£3,000 a year) with family allowance and membership of F.S.S.U. Further particulars may be obtained from the undersigned with whom applications (12 copies) must be lodged not later than 11th February, 1961. *(Candidates outside the British Isles may submit one copy only.)*

Registrar:
University Office,
46, North Bailey,
Durham.

THE UNIVERSITY of MANCHESTER

Applications are invited for the following posts in the Department of Physics of the Faculty of Science.

LECTURER IN PHYSICS (Experimental)
LECTURER IN THEORETICAL PHYSICS
ASSISTANT LECTURERS IN PHYSICS

The research interests of the Department include Nuclear and High-Energy Physics, Optics, Low Temperature and Molecular Physics. Duties to commence as soon as possible. Salary scales: Lecturer, £1,050 to £1,850 per annum, initial salary according to qualifications and experience; Assistant Lecturer £800 to £950 per annum. Membership of F.S.S.U. and Children's Allowance Scheme. Applications must be sent not later than **January 14th 1961** to the Registrar, the University, Manchester 13, from whom further particulars and forms of application may be obtained. Applications by airmail letter in the first instance will be received from overseas candidates, who should state the names and addresses of at least three persons to whom reference can be made.

AUSTRALIA
COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION

RESEARCH CHEMIST

The Organization's Division of Soils, Adelaide, invites applications for the position of Research Chemist at the Tasmanian Regional Laboratory, Hobart, Tasmania, from Honours graduates, majoring in Physical or Inorganic Chemistry with some years' post-graduate research experience in soil chemistry, or in geochemistry or in some phase of the chemistry of micro-nutrients. The Tasmanian Laboratory is engaged on the study of the cobalt status of Tasmanian soils in relation to soil type, productivity and animal health. As a result of a grant from the Wool Industry Fund the programme on availability of cobalt in different soils, fixation by soils, losses by leaching and uptake by plants is to be intensified and the appointee is required to initiate, organize and actively participate in this programme. He will have the assistance of a qualified chemist and technical assistant and good laboratory and glass house facilities are available.

The appointment will be for an initial period of three years.

SALARY: dependent on qualifications and experience within the ranges: £A1,510-2,265 p.a. or £A2,395-2,720 p.a.

Salary for women will be £A180 p.a. less than corresponding rates for men.

Promotion within C.S.I.R.O. is by merit and may ultimately go beyond the upper limit of the scale within which the original appointment is made.

Fares paid and if appointment is not extended, return fares also paid.

Further information on conditions etc. supplied on application to:

Mr. E. J. Drake, Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, LONDON, W.C.2.
to whom application (quoting Appointment No. 273/1) should be addressed by the 11th **FEBRUARY, 1961.**

THE UNIVERSITY OF LEEDS

Department of Mathematics

Applications are invited for appointment as PROFESSOR OF MATHEMATICS (either Pure or Applied) at a salary not less than £2,700 a year. The Chair is intended for a mathematician having research interests in one or more branches of mathematics related in a general or in a particular way to some field of technology. Applications (sixteen copies) stating date of birth, qualifications and experience, together with the names of three referees, should reach the Registrar, The University, Leeds, 2 (from whom further particulars may be obtained) not later than February 14th, 1961. Applicants from overseas may apply in the first instance by cable, naming three referees, preferably in the United Kingdom.

D.S.I.R. Road Research Laboratory, Harmondsworth, Middlesex, requires Scientific Officers or Senior S.Os. for research: (1) PHYSICISTS on rheology of solid-liquid systems and of viscous and visco-elastic fluids to provide basic information for design of bituminous and concrete road mixtures. (Ref. A.521/OA); (2) CHEMISTS on problems of surface chemistry and other physico-chemical aspects of behaviour of bituminous road materials; also on problems arising from presence of organic matter in soils. (Ref. F.857/OA); (3) CIVIL and MECHANICAL ENGINEERS on (a) mechanical mixing and laying of bituminous road surfacing materials, (b) problems of design and construction of earthworks for roads (practical experience of site work an advantage), (c) stabilised soil and cement-bound base materials. (Ref. E.473/OA). Varied and interesting work both in laboratory and field, providing contacts with other scientists and engineers in U.K. and abroad. Facilities for qualifying for A.M.I.C.E. for posts (3) above. Quals. 1st or 2nd Class Hons. degree or equiv. for S.S.O. (at least three years' post-graduate experience). Salary (men) S.O. £730-£1,205. S.S.O. £1,330-£1,640. Prospects of promotion in middle-30's to P.S.O. £1,700-£2,375. Forms from Ministry of Labour, Technical and Scientific Register (Ks), 26, Kean Street, London, S.W.1 (quote appropriate reference). Closing date 31 January 1961.

UNIVERSITY OF SYDNEY

SENIOR LECTURESHIP AND LECTURESHIP/SENIOR LECTURESHIP IN PHYSICS

Applications are invited for the above-mentioned posts. One appointee will work with Professor C. N. Watson-Munro in the field of plasma physics in the Wills Thermonuclear Physics Department and the other appointee will work with Dr. B. Y. Mills in the Chatterton Astronomy Department.

The salary for a Senior Lecturer is within the range £A2,550 x 95-£3,000 per annum; for a Lecturer within the range £A1,730 x 105-£2,435 per annum. In each case cost of living adjustments will be allowed. The salary is subject to deductions under the State Superannuation Act. The commencing salary and grade of appointment will be fixed according to the qualifications and experience of the successful applicant.

Under the Staff Members' Housing Scheme in cases approved by the University and its Bankers, married men may be assisted by loans to purchase a house.

Further particulars and information as to the method of application may be obtained from the Secretary, ASSOCIATION OF UNIVERSITIES OF THE BRITISH COMMONWEALTH, 36 Gordon Square, London, W.C.1.

Applications close, in Australia and London, on 3rd MARCH, 1961.

RHODESIA AND NYASALAND

The Federal Ministry of Education invites applications from Science Graduates for teaching appointments in European schools. Applicants should be men under 50 and single women under 45.

SALARY SCALE

MEN: £866.5.0 x £78.15.0-£943 x £52.10.0-£1050 x £105-£1260 x £52.10.0-£1732.10.0.
WOMEN: £750 15.0 x £68 5.0-£819 x £42-£945 x £52 10.0-£1470.

One increment is allowed for each year of previous recognised experience up to a maximum of six.

Service is normally permanent and pensionable, but a limited number of contract posts are offered, carrying Special Responsibility Allowances up to £150. In addition there are numerous posts of Special Responsibility on permanent terms.

Graduates without postgraduate training but with some successful experience will be considered and there is a scheme for training Graduates in the Department of Education of the University College of Rhodesia and Nyasaland in Salisbury.

For further information and application forms please apply to: The Education Liaison Officer (NS), Rhodesia House, 429 Strand, London, W.C.2.

UNIVERSITY OF SYDNEY

LECTURESHIP AND SENIOR LECTURESHIP IN PURE MATHEMATICS

Applications are invited for the above-mentioned positions.

Salary for a Lecturer is within the range £A1,730 x 105-£2,435 per annum; for a Senior Lecturer within the range £A2,550 x 95-£3,000 per annum and will be subject to deductions under the State Superannuation Act. In addition, in each case, cost of living adjustments will be paid. The commencing salary will be fixed according to the qualifications and experience of the successful applicant.

Under the Staff Members' Housing Scheme, in cases approved by the University and its Bankers, married men may be assisted by loans to purchase a house.

Further particulars and information as to the method of application should be obtained from the Secretary, ASSOCIATION OF UNIVERSITIES OF THE BRITISH COMMONWEALTH, 36 Gordon Square, London, W.C.1.

Applications close, in Australia and London, on 24th FEBRUARY, 1961.

APPOINTMENTS AND SITUATIONS VACANT

7s. per line—Box Number 1s. extra.

TEXTILE RESEARCH

A technologist is required by leading Company in its own particular field to carry out research and development work on industrial textiles. Qualifications desired are

(a) H.N.C. (weaving or spinning)
(b) A.T.I. or diploma or degree,

plus practical experience of carding and/or spinning, particularly of cotton or woollen waste. Interest in experimental work is essential.

High salary will be paid to candidate obtaining this position.

Letter containing a brief outline of education and career to date should be addressed to **BOX No. C.570, NEW SCIENTIST.**

HER BRITANNIC MAJESTY'S

CIVIL SERVICE COMMISSION

and

THE UNITED KINGDOM

ATOMIC ENERGY AUTHORITY

will be holding joint

Selection Boards

in

SEVERAL CENTRES

throughout the United States of America

beginning

MARCH 27th, 1961,

to interview candidates for

SENIOR and JUNIOR FELLOWSHIPS

and for

PERMANENT APPOINTMENTS

in the

SENIOR SCIENTIFIC OFFICER

and

SCIENTIFIC OFFICER GRADES

in British Government Research and Development Establishments and in the Establishments of the United Kingdom Atomic Energy Authority.

British scientists resident in the United States of America are invited to apply for further details to:

THE DIRECTOR,
UNITED KINGDOM SCIENTIFIC MISSION,
1907 K STREET, N.W.,
WASHINGTON, 6, D.C.

The closing date for receipt of applications in Washington will be:

1st FEBRUARY, 1961

CHIEF EXECUTIVE

for a major Group of Companies operating in a number of industries involving mainly products in the plastics and rubber field and with principal production Unit in the East Midlands. This is a new appointment offering immediate scope and designed to provide for management succession at the highest level within the foreseeable future. Appointment of the applicant who proves to be a success to the Group Board is envisaged. Initial remuneration will be subject to negotiation, but will be about £4,000 p.a. plus substantial profits participation, non-contributory pension scheme, Company car etc.

The Chief Executive will be responsible only to the Chairman for the co-ordination and control at the highest management level of the East Midlands Unit which employs a large number of people and consists of manufacturing plants, extensive research and development laboratories, centralised administration etc. He will be in complete control of this Unit and will have appropriate authority to exercise his functions. His principal task will be to achieve increased efficiencies in every aspect of operations and to act in complete charge administratively, subject only to the Chairman.

Qualifications desired are first-class industrial and commercial management experience, preferably obtained in the plastics, chemical or allied industries, with evidence of marked ability to provide intelligent and dynamic leadership. Sound knowledge and experience of the application of modern management techniques, including especially management accounting and production economics generally are also necessary. Preferred age 40-50.

Please write briefly in first instance, quoting Reference No. 910, to:

AA LPO

ASHLEY ASSOCIATES LIMITED
PETER HOUSE · MANCHESTER 1
Retained to advise on this appointment
THE STRICTEST CONFIDENCE WILL BE OBSERVED AND NO DETAILS OF CANDIDATES WILL BE PASSED TO CLIENTS WITHOUT CANDIDATES' PERMISSION

JOHN INNES INSTITUTE require an assistant with chemical background to help in biochemical investigations in potatoes in the Department of Potato Genetics. The appointment will be in the Assistant Experimental Officer grade, and a Pass Degree or equivalent qualification is required. Salary will be in the range £520-£745 p.a. according to age and experience. Superannuation. Applications with the names of two referees, should be addressed to the Secretary, Bayfordbury, Hertford, not later than the 7th February, 1961.

HILL FARMING RESEARCH ORGANISATION

Applications are invited from Honours Graduates (or those expecting to graduate with Honours in 1961) in Botany, Agricultural Botany or Plant Husbandry for a vacancy which will shortly arise in the grade of SCIENTIFIC OFFICER on the Organisation's Botany Staff at the hill research farm of Sourhope, nr. Kelso, Roxburghshire. Salary scale £690-£1,144 per annum. Superannuation under F.S.S.U. Further particulars and application form may be obtained from The Secretary, Hill Farming Research Organisation, 45 Palmerston Place, Edinburgh 12. The closing date for applications will be 28th January, 1961.

UNITED KINGDOM ATOMIC ENERGY AUTHORITY

require an

ASSISTANT EXPERIMENTAL OFFICER

to assist scientific and engineering staff in a variety of interesting problems in electronics associated with nuclear physics research.

Applicants should preferably possess a pass degree in Physics or Electronic Engineering or an H.N.C. in Electronic and Electrical subjects. Younger applicants with G.C.E. in five subjects, including English Language and two scientific or mathematical subjects at 'A' level will also be considered.

SALARY: £475 (at age 18)-£815 (at age 26 or over)-£1,005 p.a.

Superannuation Scheme. Financial assistance towards house purchase will be available for married officers living beyond daily travelling distance. Excellent modern hostel facilities for single people

For application form send postcard (or letter) to the Senior Recruitment Officer, A.W.R.E., Aldermaston, Berks., quoting Ref. No. 2859/215.

JUNIOR TECHNICIAN required in Biochem. Dept. Qualifications I.M.L.T. Intermediate, desiring to work for A.I.M.L.T. Biochemistry. Salary, etc., as per Whitley Council Scale. Apply to Secretary, GROUP 9 LABORATORY, 6, Rickmansworth Road, Watford, Herts.

ELECTRONIC COMPONENTS AND SALES

The Sales Departments of the Capacitor and the Transistor Divisions offer to YOUNG MEN aged 20-30, who have a knowledge of electrical engineering and also commercial experience, progressive posts in their Sidcup offices, dealing with customers' correspondence, telephone inquiries and statistical work connected with sales administration. Both these posts offer excellent experience to young men who aspire to be sales engineers, provided they are prepared to continue their studies for O.N.C.

Write in confidence, giving a personal history of age, qualifications and experience and salary to:

W. J. YEOMANS,
Personnel Manager,
STANDARD TELEPHONES AND CABLES LIMITED,
Footscray, Sidcup, Kent.

THE BRITISH SOCIETY FOR RESEARCH IN AGRICULTURAL ENGINEERING requires SCIENTIFIC OFFICER (REF. N.1) to take charge initially of small team investigating the effects of design on the efficiency of machines used in harvesting of grass and clover seeds. 1st or 2nd class honours degree in Engineering or Physics essential, with post-graduate experience in field experimental work. Salary scale: £690-£1144, with starting salary according to age and experience.

ASSISTANT EXPERIMENTAL OFFICER (REF. N.2) also required for general duties in connection with above problems and with barn hay drying. Pass degree in Engineering, Science or Physics essential, with practical experience of experimental work; knowledge of instrumentation desirable. H.N.C. in Engineering or Applied Physics or Chemistry might also be acceptable. Salary scale: £600 at age 22 rising to £920, with starting salary limited to £745 at age 26.

Both posts superannuable, 5-day week, promotion prospects. Application forms from Secretary, N.I.A.E., West Park, Silsoe, Bedfordshire.

Central Electricity Generating Board

Research and Development Department

SCIENCE GRADUATES

Applications are invited from Science Graduates (men and women) interested in fundamental or applied research work associated with the continuing expansion of the Electricity Supply Industry. Students intending to graduate next summer are also invited to apply.

Vacancies exist in the following fields:

PHYSICS:	**Reactor Science, Solid State, Meteorology, Magnetohydrodynamics.**
CHEMISTRY:	**Combustion, Corrosion, Analysis, Physical Chemistry.**
MATHEMATICS:	**Computing, System Control, General Studies.**
ENGINEERING:	**Nuclear, Chemical, Mechanical.**
ELECTRONICS:	**Communications, Instrumentation, Data Handling.**
METALLURGY AND MATERIALS:	**Ceramics, Dielectries.**
ELECTRICAL ENGINEERING:	**High Voltage, Transmission, Insulation, Gas Discharges.**

Applicants should preferably be under 26 years of age, and possess a good honours degree or equivalent qualification. Some postgraduate industrial or university research experience is desirable, but new graduates who are acceptable will be given training where appropriate. There are also vacancies for staff who are slightly less qualified academically.

● **SALARIES will be fully commensurate with experience, ability and qualifications. Initial appointments will, save in exceptional cases, be made within the Research and Development recruitment grade, for which the maximum salary is £1,325 p.a. Rapidity of promotion to higher grades rests entirely on merit. Successful candidates can be assured of excellent career prospects, and of being engaged on forward-looking work with freedom to publish their results.**

Assistance may in certain circumstances be given with house purchase.

● **APPLICATIONS stating age, qualifications, experience, present position, and salary, to the Personnel Officer, 24/30, Holborn, London, E.C.1. Envelopes should be marked "Confidential Ref. NS/454."**

RESEARCH OPPORTUNITIES IN THE U.S.A.

Well-known electrical manufacturers in the U.S.A. have two attractive vacancies in their research laboratories for

PHYSICAL CHEMISTS OR PHYSICISTS

Ph.D. or similar standard with research experience would be desirable, but newly qualified M.Sc.'s or Ph.D.'s would also be considered.

The work is concerned with research in the fields of glass and ceramic electronic materials. A sound basic knowledge and wide interests covering electrical materials such as semiconductors, dielectrics, ferroelectrics or ferromagnetics is desirable.

The posts call for high technical attainment and carry attractive salaries in accordance with qualifications and experience. Interviews will be arranged in this country. Please apply to Box No. C569 New Scientist.

WOOL INDUSTRIES RESEARCH ASSOCIATION

A vacancy occurs for a **MATHEMATICIAN** with special interest in applied mathematics or theoretical physics, lively mind, and interest in investigating wide variety of problems (mechanical, physical, numerical, etc., in nature) arising in textile research. Ph.D. or previous research experience desirable. Starting salary up to £1,500 p.a. (with F.S.S.U. benefits), according to qualifications and experience. Apply to the Association, Torridon, Headingley Lane, Leeds 6.

RESEARCH INSTITUTE (ANIMAL VIRUS DISEASES), PIRBRIGHT, SURREY, invites applications:

(1) For an appointment in the Tissue Culture Section. Applicants should have an Honours Degree in Biochemistry or Zoology and have experience of culture techniques applied to mammalian tissue. Salary in Principal Scientific Officer grade, £1,630-£2,325 or Senior Scientific Officer grade, £1,230-£1,590, depending on age, qualifications and experience. Superannuation under F.S.S.U. House available for married applicant. Applications to the Secretary.

(2) From young graduate physicists or physical chemists for a post in the Biophysics Department. The successful candidate will be engaged upon the application of a variety of physical-chemical techniques to the study of viruses and related biological systems, and will be encouraged to work for a higher Degree. Current methods of investigations include electron-microscopy, ultracentrifugation, light scattering and X-irradiation, etc. Interest rather than experience is required at this stage. The appointment will be made according to age and experience in the Scientific Officer grade, £690-£1,175, or Senior Scientific Officer grade, £1,250-£1,590. Superannuation under F.S.S.U. House available for married applicant. Applications to the Secretary.

THE UNIVERSITY of MANCHESTER

RESEARCH ASSISTANT IN REGISTRAR'S OFFICE

An investigation is to be undertaken in the Registrar's Office into the application of electronic computing methods to such administrative processes as, for example, statistical analyses, registration of students, timetables for examinations, compilation and maintenance of records etc. It is proposed to appoint a RESEARCH ASSISTANT in the Registrar's Office for a period of about two years to take part in this investigation. Applications are invited from men or women graduates with experience in digital computing for this appointment. Facilities will be available for the person appointed to work on ATLAS, the computing machine at present being developed in the computing machine laboratory. The salary will be in accordance with qualifications and experience, and the post will carry membership of the F.S.S.U. and Children's Allowance Scheme. Duties to commence as soon as possible. Applications should be sent not later than January 14th, 1961, to the undersigned, from whom further particulars and forms of application may be obtained.

VINCENT KNOWLES,
Registrar.

We require

ENTERPRISING INFORMATION SCIENTISTS

with good academic qualifications to undertake a variety of work including abstracting, compiling bibliographies, answering technical enquiries and organising information projects. A broad scientific background is needed and some practical experience of instruments would be an advantage. Salary range £600 to £1,500 per annum, with good prospects.

Apply, quoting reference AJM, to the Director, J. Thomson, M.A., D.Sc.,
British Scientific Instrument Research Association,
Sira, South Hill, Chislehurst, Kent.

INSTITUTE OF CANCER RESEARCH: ROYAL CANCER HOSPITAL. A vacancy exists in the Physics Department, Sutton, Surrey, for a **BIOCHEMIST** to join a team engaged in the study of trace metal metabolism using radioactive tracer techniques. Candidates should possess a first or second class honours degree in biochemistry or chemistry and the possession of a higher degree would be an advantage. Salary in accordance with M.R.C. scales in the range £1,100-£1,300. Applications giving the names of two referees to the Secretary, 33, Sumner Place, S.W.7, quoting ref.: 300/G/8.

CENTRAL ELECTRICITY GENERATING BOARD

Eastern Division

Applications are invited for the following appointment:

MATHEMATICAL ASSISTANT — BRADWELL (NUCLEAR) GENERATING STATION (ESSEX)

Salary range £670-£805 per annum.
The commencing salary will depend upon age and qualifications.
Applicants should be young mathematics graduates.

The work will be varied in nature, involving analysis and calculations based on physical measurements made on the nuclear reactors, in order to ensure their safe and efficient operation.

Opportunities to write programmes for a large, modern computer (I.B.M. 709) will arise, and a period of training for this type of work will be provided.

Applications, quoting Reference No. S.V.1417, stating age, details of education, experience and present position, should be sent to the Controller, Central Electricity Generating Board, Eastern Division, West Farm Place, Chalk Lane, Cockfosters, Barnet, Herts., by **14th January, 1961.**

BRISTOL COLLEGE OF SCIENCE AND TECHNOLOGY
Ashley Down, Bristol, 7.

The Governors invite applications for the post of ASSISTANT, Grade B, in the Department of Physics. Applicants should possess an Honours Degree in Physics and have had research or industrial experience in some branch of Applied Physics. Teaching experience desirable.

Salary, according to experience and qualifications, within the range £790 to £1,435.

Application forms and details from the Registrar.

THE MANCHESTER COLLEGE OF SCIENCE AND TECHNOLOGY

RESEARCH IN RHEOLOGY

Applications are invited from physicists for a position as experimental Research Assistant in the Department of Mathematics to continue and develop a fundamental investigation of the rheological properties of concentrated polymer solutions. Recently developed apparatus is available for the measurement of flow birefringence and normal and shear stress components in shear flow. The work calls for initiative in the design and construction of new apparatus, and for the ability to perform series of observations of sustained accuracy. Candidates should possess a good Honours Degree in Physics.

The position is tenable for two years in the first instance. Salary will be £675 per annum, and the post will be superannuable under F.S.S.U. Applications should be forwarded to the Registrar, The Manchester College of Science and Technology, Sackville Street, Manchester, 1, on or before 31st January, 1961.

Mullard

THE MULLARD RADIO VALVE CO. LTD.

FERRITES

A Company of international reputation who are making rapid progress in the field of Ferrite Applications require two Electrical Engineers or Physicists for the Development Section of the Ferrite Division to assess qualities of development ferromagnetic materials and introduce new ferrite components into a Production Unit.

Investigations are being carried out in many fields including memory core for computer applications and ferrites for telecommunications, microwave and piezomagnetic applications.

These posts require young men of high calibre having an aptitude for research and also the ability to drive good ideas into factory production.

A knowledge of statistical quality control techniques would be an advantage.

A Mechanical Engineer with a bias towards light Electromechanical Engineering is also required for development work on magnetic memory storage systems

Preferably he should have experience in the design of Electromechanical Equipment and printed circuit techniques.

Minimum qualifications are a degree or equivalent in Mechanical Engineering but applicants with other qualifications and suitable experience will also be considered.

The posts carry salaries which recognise the importance of this work and there are considerable opportunities for personal development in this field. General conditions of employment are excellent and a 38½ hour week is worked.

Applications, in confidence, should be addressed to the Personnel Officer, Mullard Radio Valve Co. Ltd., New Road, Mitcham Junction, Surrey, bearing reference JFG/FI.

"Mullard" is the Trade Mark of Mullard Limited

SHELL

"SHELL" RESEARCH LIMITED

require a

SENIOR TECHNICIAN

for the

CHEMISTRY DIVISION

at their Tunstall Laboratory, near Sittingbourne, Kent.

The work of the Chemistry Division is extremely diverse, and includes the formulation of chemicals for biological tests, the design and operation of inhalation chambers, and the development of microanalytical techniques for the determination of biologically active compounds in tissues and body fluids. The Laboratory has an extensive programme and there are wide opportunities for development in all these fields.

Applications are invited from candidates with Higher National Certificate in Chemistry, or equivalent, and some 10-15 years' laboratory experience.

Salary will be based entirely on qualifications and experience. There is an attractive Pension Scheme together with other staff benefits.

Please apply by letter, giving full details to:

Personnel Recruitment/T.C.,
"Shell" Research Limited,
St. Helen's Court,
LONDON, E.C.3.

TECHNICIANS required for research projects in Nutrition Department, one with laboratory experience and one preferably with experience of animal work. University salary scales; good conditions and holidays. Apply in writing to the Secretary, QUEEN ELIZABETH COLLEGE (University of London), Campden Hill Road, W.8.

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THE BRITISH SOCIETY FOR RESEARCH IN AGRICULTURAL ENGINEERING requires INFORMATION ASSISTANT with honours degree or similar qualification in Engineering or Agriculture and a knowledge of languages. Duties involve mainly abstracting from technical literature; ability to write concise English is essential. Starting salary according to age and experience in scale £690-£1144. Superannuation scheme. Further details and application forms from Secretary, N.I.A.E., Silsoe, Beds.

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THE LONDON HOSPITAL, Whitechapel, E.1. has a vacancy for BIOCHEMIST (basic grade) in the Metabolic Ward Laboratory. Candidates should have B.Sc Honours Degree in Chemistry or Biochemistry. The successful applicant will be trained for a career in hospital biochemistry and opportunities for developmental work in biochemical analyses will be provided, so some post-graduate experience of these is desirable. Write to House Governor, giving names of two referees.

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Full details concerning the above course may be obtained from Head of Department of Engineering, Kingston Technical College, Kingston 1204.

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Details from the Registrar, Brunel College of Technology, Woodlands Avenue, Acton, W.3.

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THEORIES OF ACTIVATION AND ENERGY TRANSFER. THE STUDY OF VIBRATIONALLY EXCITED MOLECULES BY FLASH PHOTOLYSIS AND FLUORESCENCE.
EXPERIMENTAL TECHNIQUES OF STUDYING FAST REACTIONS IN GASES AND LIQUIDS.
RELAXATION PROCESSES IN SOLUTION AND FAST ELECTRODE REACTIONS.
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Further details and forms of application may be obtained from:

THE SECRETARY OF THE SUMMER SCHOOL, Department of Physical Chemistry, Lensfield, Cambridge.

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Details and registration forms from the Head of the Chemistry Department, Kingston Technical College, Fassett Road, Kingston-upon-Thames.

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